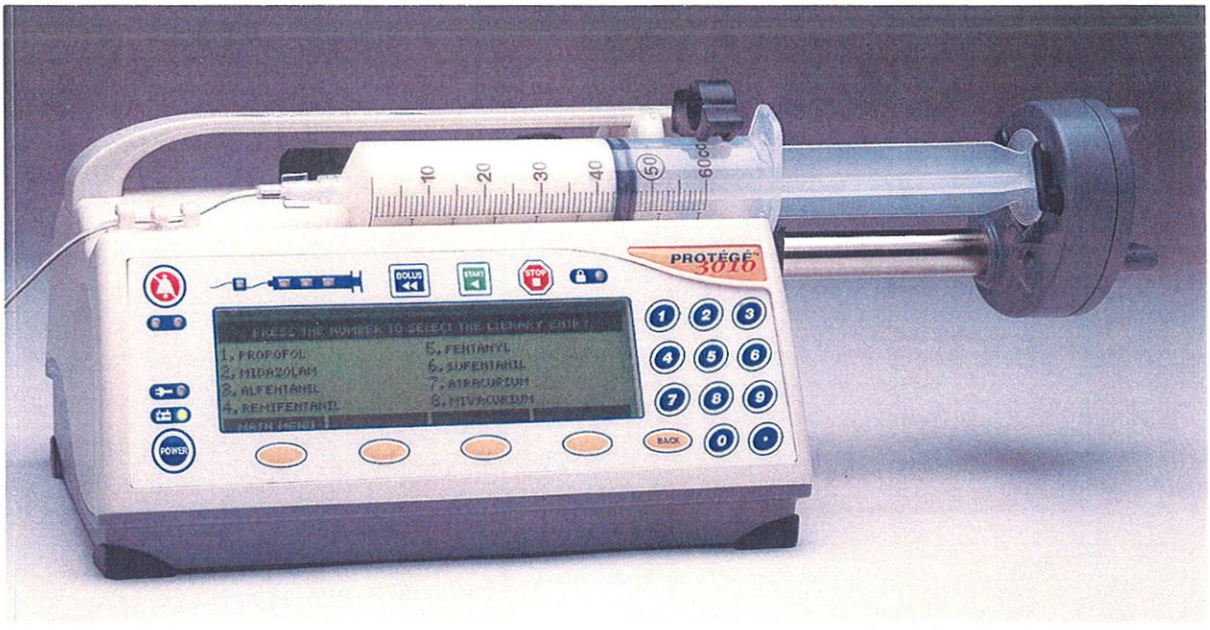

MEDEX

3000 SERIES

SYRINGE INFUSION PUMP

Manufactured by:
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Duluth, Georgia 30097 USA

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Technical Service Manual

Table of Contents

TABLE OF CONTENTS 1

INTRODUCTION 1
Contents of this Service Manual 1
Understanding "Biomed" Mode 2
What is Biomed? 2
Biomed Software Program -- Major Options 2

PART 1: SCHEDULED MAINTENANCE 3
Biomed Maintenance Tools 3
Service Warnings 3
Periodic Maintenance 4
Installation/Quick Check-out 4
Cleaning and Care 4
MANDATORY Annual Maintenance Testing 6
Battery Maintenance 11
Shallow Discharge (CPI) Record 11
Battery Calibration Procedure 11
Requirements for Battery Pack Replacement 12

PART 2: THEORY OF OPERATION 13
Technical Definitions 13
Overview of Operation 14
Controlling Motor Functions 14
Infusion Control & Safety Functions 14
Pump Design Description 15
Logic Core of 3000 Series Pumps 15
Main Circuit Board 15
Interconnect Printed Circuit Board 17
Plunger Printed Circuit Board 17
Main Board – Schematic Level 18
Logic Kernel Description 18
Power Control Description 24
DC to DC Converter 25
Front Panel Interface Description 26
Graphic Display Interface Description 27
Motor Drive Description 28
Sensors Interface Description 28
Speaker Drive Description 30
Plunger Board – Schematic Level 31
Force Preamplifier Function 31
Plunger Flipper Sensor Function 31
Interconnect Board – Schematic Level 32
AC Power Detection Description 32
External DC Power Conditioning / Detection Description 32
Infrared Serial Data Port Description 33
Battery Management Description 33
Battery Board – Schematic Level 35
Battery Gauge Function 35
Severely Depleted Battery Monitor 35

PART 3: TROUBLESHOOTING 37
Problem Solving Alarms / Alerts 37

Types of Alarms / Alerts 37
Alarm Messages & Priorities 37
System Advisory Alarms 40
System Failure Alarms 41
General Troubleshooting 45
Medex Service and Support 47
Using Medex Service Assistance 47
Returning a 3000 Series Pump for Repair 47
Using Biomed Program for Troubleshooting 48
Starting Biomed Software Program 48
Biomed CALIBRATION 49
Biomed DIAGNOSTICS (screen 1 of 2) 49
Biomed DIAGNOSTICS (screen 2 of 2) 51
Biomed UTILITIES 52
Biomed UPDATE FIRMWARE 54
Set Language (Not available on 3010 and 3010a) 54

PART 4: PARTS REPLACEMENT 55
Maintenance Warnings/Cautions 55
Opening & Closing the Pump Housing 56
Opening the Pump Housing 56
Closing the Pump Housing 56
Battery Pack 57
Removing the Battery Pack 57
Replacing the Battery Pack 57
Verifying Battery Function After New Battery Replacement 57
Interconnect Board 57
Removing the Interconnect Board 58
Replacing the Interconnect Board 58
Verify Interconnect Board Function 58
Speaker 59
Speaker Removal 59
Speaker Replacement 59
Verifying Speaker Function 59
AC Power Supply 60
Removing AC Power Supply 60
Replacing the AC Power Supply 60
Verify AC Power Supply Function 60
AC Input Assembly 61
Removing AC Input Module Assembly 61
Replacing AC Input Module Assembly 61
Verifying AC Input Assembly Module Function 61
Bottom Housing Plastic 62
Removing the Bottom Housing 62
Replacing the Bottom Housing 62
Main Board 63
Removing the Main Board 63
Replacing the Main Board 63
Drive Train Assembly 65
Motor Unit (Motor, Worm, Worm Gear) 65
Position Potentiometer 66
Clutch Assembly 67
Leadscrew 67
Clutch or Clutch Cam 68
Plunger Cable 68
LCD and Back Light 69

Removing LCD and/or Back Light Assembly 69
Replacing the LCD and/or Back Light Assembly 69
Verify LCD & Back Light Assembly Function 70
Keypad 70
Removing the Keypad 70
Replacing the Keypad 70
Syringe Barrel Clamp Assembly 72
Barrel Clamp Head 72
Barrel Clamp Body Assembly 72
Ear Clip, Handle & Guide 73
Ear Clip 73
Ear Clip Optical Sensor 73
Handle 74
Tubing Guide 74
Plunger Case Assembly 76
Plunger lever 76
Plunger Case Disassembly 76
Cam Gear and Timing Plate 76
Flipper and Flipper Gear 77
Plunger Board 77
Force Sensor 78
Left Plunger Case 79

PART 5: CALIBRATION & ADJUSTMENT 81
Using Biomed Calibration 81
Calibrate (Syringe) Size and Position 82
Calibrate Force Sensor 84
Calibrate Plunger Position 86
Calibrate Syringe Size Sensor 87
Adjust Contrast (Voltage) Setting 87
View Calibration Data 88
Save Changes and Exit 88

PART 6: SCHEMATICS & PCB ASSEMBLIES 89
System Layout 89
Main Board Schematics 90
Main Board / Logic Kernel 90
Main Board / Power Control Logic Core 94
Main Board / DC-DC Converter 96
Main Board / Keypad Interface 98
Main Board / Graphic Display Interface 101
Main Board / Motor Drive 102
Main Board / Syringe Sensing 103
Main Board / Position Sensing 104
Main Board / Force Sensing 105
Main Board / Pressure Sensing 106
Main Board / Speaker Drive 107
Main Board / ACU-ICE Socket 108
Main Board Assembly Drawing – Top Side 109
Main Board Assembly Drawing – Bottom Side 110
Main Board Assembly – Parts list 111
Plunger Board Schematic 116
Plunger Board / Force Preamplifier 116
Plunger Board / Flipper Sensor 117
Plunger Board Assembly Drawing 118
Plunger Board Assembly – Parts list 119

Battery Gauge Schematic 120
Interconnect Board Schematic 121
Interconnect Board / Power Control 121
Interconnect Board / Battery Management 122
Interconnect Board / Infrared Serial Communications 123
Interconnect Board Assembly Drawing 124
Interconnect Board Assembly – Parts list 125

PART 7: ASSEMBLY DRAWINGS & PARTS LISTS 127
Assembly Drawings 127
3000 Series Main Pump Assembly 128
3000 Series Main Pump Assembly – Parts list 129
Case Bottom Assembly 130
Case Bottom Assembly – Parts list 131
Case Top Assembly w/Plunger 132
Case Top Assembly w/Plunger – Parts list 133
Case Top Assembly Without Plunger 134
Case Top Assembly without Plunger – Parts list 135
Barrel Clamp Assembly 137
Barrel Clamp Assembly – Parts list 138
Drive Train Assembly 139
Drive Train Assembly – Parts list 140
Clutch Assembly 141
Clutch Assembly – Parts list 142
Accessories – Parts list 143
Calibration & Repair – Parts list 144

PART 8: APPENDICES 145
Appendix 1. Glossary of Technical Terms 145
Appendix 2. Retest Guidelines 149
Retest Guidelines Table 149
Appendix 3. Index 151

INTRODUCTION

Contents of this Service Manual

This is the technical service manual for 3000 Series Syringe Infusion pump manufactured by Medex. Its purpose is to provide the technical information necessary for maintenance, troubleshooting, and repair of these infusion pumps.

☞ This manual does not contain information on operating or configuring various models within the 3000 Series. Such information is found in manuals specific to each individual model, (*e.g.*, 3500 Operations Manual). The sections of this manual are detailed in the table below:

Section	What It Contains
Introduction	Overview of contents and purpose of this manual.
1. *Scheduled Maintenance*	List of tests for required annual maintenance, and the procedure for completing each test.
2. *Theory of Operation*	Descriptions of the systems which control the operation of 3000 Series syringe infusion pump.
3. *Troubleshooting*	Tables of failure messages together with problem descriptions and possible solutions. Also includes an overview of Biomed *Diagnostics & Utilities*.
4. *Parts Replacement*	Detailed procedures for removal and replacement of parts of 3000 Series syringe infusion pump.
5. *Calibration*	Detailed procedures for calibration of 3000 Series syringe infusion pump.
6. *Schematics & PCB Assemblies*	Contains board level schematics & PCB assembly drawings.
7. *Assembly Drawing & Parts Lists*	Contains mechanical assembly parts lists and replacement parts lists for repairs.
8. *Appendices*	Contains technical information relevant to 3000 Series syringe infusion pumps.

Authorized Use of this Manual

This manual is only intended for use by trained biomedical technicians, who are authorized by their institution to perform maintenance and repair of critical medical devices.

WARNING! Attempts to repair or maintain a pump by personnel without proper qualifications or training may create a major hazard which could result in serious injury or death to the patient or the user.

WARNING! Use only approved parts and procedures for repair and maintenance of this pump. Failure to follow this manual may create a major hazard which could result in serious injury or death to the patient or the user.

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Understanding "Biomed" Mode

Periodic maintenance and troubleshooting on 3000 Series infusion pumps are aided by use of the "Biomed" software interface.

What is Biomed?

The Biomed feature is the *special utility* intended for use only by trained biomedical service technicians.

- Biomed has its own security access code.
- Biomed is for calibration of the pump's sensors.
- Biomed is for diagnosis of digital and analog sensors contained in the pump.
- Biomed allows access to infusion history log and alarm history log stored in the pump.

Authorized Biomed Access

Never use Biomed service features unless you are trained in maintenance on 3000 Series syringe infusion pump and have been authorized to use the Biomed service program.

Biomed Software Program – Major Options

The Biomed utility has four major modes on its SELECT THE MODE screen. These are:

1. *Calibration* to check calibration values, re-calibrate sensors or set display contrast.
2. *Diagnostics* to examine analog and digital signal readings, or test the speaker, motor or display function.
3. *Utilities* to review alarm history, to review infusion history, to set time and date, to update periodic maintenance timestamp.
4. *Update Firmware* to reprogram the pump's software version through the serial interface (only available with service upgrade software diskette and instructions).

The following is an outline of the Biomed Software:

CALIBRATION	DIAGNOSTICS
➢ CAL SIZE AND POSITION ➢ CAL FORCE SENSOR ➢ CAL PRESSURE SENSOR ➢ CAL PLUNGER POSITION ➢ CAL SYRINGE SIZE SENSOR ➢ ADJUST CONTRAST ➢ VIEW CALIBRATION DATA ➢ SAVE CHANGES AND EXIT	➢ MONITOR ANALOG SENSORS ➢ MONITOR DIGITAL SENSORS ➢ MONITOR A2D SELF TEST ➢ MONITOR 6811 A2D GROUP1 ➢ MONITOR 6811 A2D GROUP2 ➢ FORCE SENSOR TEST ➢ PRESSURE SENSOR TEST ➢ MOTOR DRIVE TEST ➢ AUDIO TEST ➢ MONITOR BATTERY STATUS ➢ DISPLAY TEST ➢ INDICATOR TEST ➢ KEYPAD TEST
UTILITIES ➢ SET/VIEW LAST PM DATE ➢ SET TIME/DATE ➢ VIEW ALARM HISTORY ➢ VIEW INFUSION HISTORY ➢ VIEW SOFTWARE CRCS ➢ VIEW SOFTWARE VERSIONS ➢ VIEW SERVICE DATA	UPDATE FIRMWARE (SPECIAL USE ONLY FOR SOFTWARE UPDATE) SET LANGUAGE (3500 ONLY)

PART 1: SCHEDULED MAINTENANCE

Part 1: Scheduled Maintenance of the service manual defines the required preventive maintenance for keeping the 3000 Series syringe infusion pump in good operating condition.

Biomed Maintenance Tools

In order to complete maintenance, parts replacement, diagnosis and calibration of 3000 Series infusion pumps, you will need the following:

1 ea – Calibration Kit (see service parts list): Small Calibration Slug, Large Calibration Slug & Force Gauge
1 ea – new 50 or 60 cc syringe (note: the lubrication in syringes evaporates, change "test" syringes monthly)
1 ea – 3-way Stopcock
1 ea – Electrical Safety Analyzer
1 ea – Torque Screwdriver w/Phillips & Standard bits.
1 ea – ¼" open end wrench
1 ea – 6" calipers with resolution of 0.001"

Using a Torque Screwdriver

You **must** always use a *Torque Screwdriver* when re-assembling any 3000 Series pump. Where screws are used to secure components, over-tightening can strip threads or crack standoffs in the case.

☞ Unless otherwise specified, you should always torque all screws to 60 *in-oz* (approximately *0.8 Nm*).

Electrostatic-controlled Workstation

Whenever you work on the 3000 Series pump – *specifically whenever you open the pump for service* – you **must** work in an electrostatic-controlled environment. This insures you will not damage the electronic components in the pump.

Service Warnings

Warnings!	Definition
Pump Maintenance	**Only trained biomedical service personnel may service this pump.** Service personnel should disconnect the AC power cord before servicing the pump.
AC Power	**The only means of removing AC power is to disconnect the AC power cord.** While the AC power cord is attached to the pump and plugged into an AC outlet, live mains voltage is present within the pump.
Manufacturer Recommended Maintenance	**Always maintain this pump following *manufacturer recommended instructions*** in this Service Manual. An improperly maintained pump may cause serious injury to a patient or user.

Periodic Maintenance

This chapter defines the maintenance which is required for insuring the continued safe operation of 3000 Series syringe infusion pumps.

The 3000 Series pump must be tested annually, or whenever the pump has been damaged or dropped. Always check all sensor calibrations as a standard part of annual maintenance. No calibration is required to maintain pump flow delivery accuracy.

Installation/Quick Check-out

Each pump is inspected and tested prior to shipment from the factory. Some institutions require that devices entering a hospital be functionally checked before being placed into service. The following procedure is provided to meet this need.

Quick Check-out Test

	1) Plug AC power cord into AC receptacle on side of pump, then plug pump into an AC power (100 to 240 VAC) source. Verify AC indicator and battery charge indicator are lit.
	2) Press the POWER key. Verify the following on Power up ➢ Verify alarm beeps on power-up. ➢ Verify all the LED indicators are turned on & off during power up (except AC and battery). ➢ Verify that no self-tests fail during power-up. ➢ Verify the display is legible and contrast is acceptable.
	3) Unplug the AC power cord and verify that within several seconds the battery indicator begins to flash and AC indicator goes off. Re-plug the AC power cord into the unit.
	4) Perform the "Flow Delivery Accuracy Test" from the Annual Maintenance procedure below.
	5) Go to MAIN screen (use MORE for second page), select BIOMED, enter pass code "2580", select UTILITIES, select SET/VIEW LAST PM DATE, and set the PM date to today's date. Setting this PM date means that an advisory message will appear on the pump 1 year from this date. This message does not prevent normal operation of the pump, but advises the user that annual maintenance is recommended. [Note: pump is shipped from factory with date/time set to U.S.A. Eastern Standard Time, use the SET TIME/DATE utility to modify this if desired.]
	6) Perform the "AC Line Leakage Test" from the Annual Maintenance procedure below.
	7) Consult troubleshooting guide or contact Medex Technical service for failed steps in this test.
	8) After the completion of these tests the pump be should plugged into AC power to recharge the battery. [This is recommended when the battery capacity is less than 90% – look at battery gage displayed on the bottom of the power-up screen.]

Cleaning and Care

Standard Cleaning of *3000 Series* Pumps

Follow your institution's guidelines for cleaning and disinfecting of devices. The syringe pump can be safely cleaned with the following agents:

- *Common chlorine bleach diluted with water.*
- *Mild detergent mixed with water.*
- *Isopropyl alcohol 70% solution.*
- *Other surface disinfectants which are compatible with plastic materials.*

FOR BEST RESULTS: Clean by spraying or pouring cleanser directly onto a soft cloth (not directly onto the pump) and then wiping surfaces until dry.

Cleaning Cautions

Below are standard cautions you should follow when cleaning 3000 Series infusion pump:

Caution	Explanation
Avoid Organic Solvents	NEVER use organic solvents (*e.g.*, acetone), *quarternary* ammonia compounds, strong acids or strong bases to clean any portion of the pump.
Not Waterproof	The *3000 Series* is "spray resistant" but not "water proof". Never spray cleaning or other fluids directly into openings on the bottom of the pump. Never immerse the pump in water or other fluids. The *3000 Series* is "spray resistant" but not "water proof".
Avoid Spray Oils	Never use light spray oils (*e.g.*, WD40™) to clean or lubricate pump. These chemicals can damage the plastic of the pump.
Never Autoclave or Gas Sterilize	Never sterilize the pump in a steam autoclave or gas. Using an autoclave or gas sterilization can seriously damage the *3000 Series* infusion pump and void the warranty.

MANDATORY Annual Maintenance Testing

All tests on this *Required Annual Maintenance List* must be performed annually in order to insure the continued safe operation of the 3000 Series syringe infusion pump.

General Inspection	
	1) If not already performed, clean and disinfect the pump as described in the *"Cleaning and Care"* section (see previous page).
	2) Inspect for obvious physical damage, including cracked housings or torn keypads. Repair any physical damage.
	3) Verify smooth operation of syringe plunger driver, syringe release lever, syringe ear clip, and syringe barrel clamp. Clean and/or repair any damaged components.
	4) Verify the three tubing guides (hooks) on top left side are intact, and fully secured to pump housing. Replace any damaged guides.
	5) Verify force sensor seal, located behind flippers on plunger driver head, is intact and not punctured. Replace damaged seal.
	6) Inspect power cord for damage and wear. Replace damaged or worn power cord before performing any leakage current testing.
	7) Inspect pole clamp for proper operation. Verify that the screws holding pole clamp components are tight.
	8) Verify the Serial Number Label is legible and intact. Replace if label damaged.
	9) Verify the Warning Label is legible and intact. Replace if label damaged.
	10) Verify four rubber feet are attached to the bottom housing of the pump. Replace missing feet.
	11) Turn the pump on all sides and check for any loose parts internally and externally.
	12) Plug AC power cord into AC receptacle on side of pump, then plug pump into an AC power (100 to 240 VAC) source. Verify AC indicator and battery charge indicator are lit. Consult *troubleshooting guide for any failed indicator.*

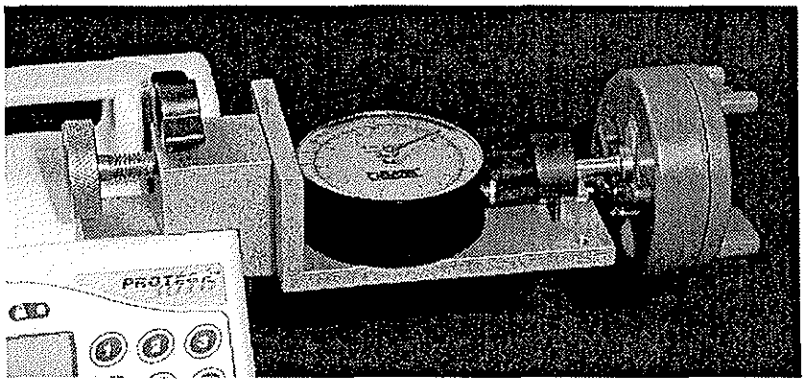
Power-up Test

Insure that no syringe is loaded in the pump and the barrel clamp is fully down. Press the POWER key. Verify the following on Power up:

	1) Verify alarm beeps on power-up.
	2) Verify all the LED indicators are turned on/off during power up (except AC and battery).
	3) Verify that battery capacity shown on screen is greater than 0%.
	4) Verify that no self-tests fail during power-up.
	5) Verify the display is legible and contrast is acceptable.
	6) Unplug the AC power cord and verify that within several seconds the battery indicator begins to flash and AC indicator goes off. Re-plug the power cord into the unit.
	7) Consult troubleshooting guide for failed steps in this test.

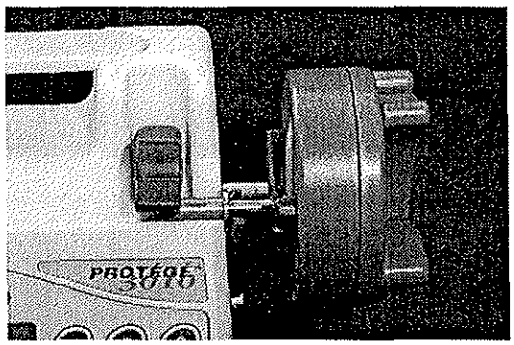
Calibration Verification

Press the MAIN or MORE soft key until selection for BIOMED appears. Press the number key for BIOMED. For the pass code, press the numbers: "2" "5" "8" "0", then the ENTER soft key. Press the number key for DIAGNOSTICS. Press the number key for MONITOR ANALOG SENSORS.



Force Sensor Check

	1) Insure that no syringe is loaded in the pump. Verify that the force reading on the screen is between -0.2 and +0.2 pounds.
	2) Load the force gauge with the foot of the gauge positioned towards the head of the plunger driver. Zero the force gauge. Using the thumbscrew of the force gauge bracket, increase the force applied until the force gauge reads 15 pounds (6.8 kilograms). Verify that the force reading on the screen is between 14.0 and 16.0 pounds.
	3) If either reading is out of specification, re-calibrate the sensor and then retest readings.



Syringe Size Sensor Check

	1) Load the small Calibration Slug into the barrel clamp (do not load the plunger driver). Keeping the barrel clamp perpendicular to the slug, move the barrel clamp head slightly back and forth to find the lowest size reading. Verify that the size reads between 0.256" and 0.272", inclusive.
	2) Load the large Calibration Slug into the barrel clamp (do not load the plunger driver). Keeping the barrel clamp perpendicular to the slug, move the barrel clamp head slightly back and forth to find the lowest size reading. Verify that the size reads between 1.244" and 1.260", inclusive.
	3) If either reading is out of specification, re-calibrate the sensor and then retest readings.

Plunger Position Sensor Check

	1) Load the small Calibration Slug into the barrel clamp. Load the plunger driver onto the end of the slug with flippers open, and about 0.1 lbs applied to force sensor (as read from the screen). Verify that the position reads between 0.680" and 0.720", inclusive. Unload the slug.
	2) Load the large Calibration Slug into the barrel clamp. Load the plunger driver onto the end of the slug with flippers open, and about 0.5 lbs applied to force sensor (as read from the screen). Verify that the position reads between 4.680" and 4.720", inclusive. Unload the slug.
	3) If either reading is out of specification, re-calibrate the sensor and then retest readings.

Plunger travel test.

Return the pump to the MAIN screen (use the BACK key to exit Biomed mode). Load an air-filled 50 or 60 cc syringe into the pump. Select ML/HR delivery mode and set flow rate to 20 ml/hr, and clear the total infused. [*Note: use a new syringe for this test as the lubrication within syringes evaporates, change "test" syringes at least monthly.*]

	1) Verify the three green infusing indicators are lit in a repeating sequence from right to left. Continue running until at least 0.033 ml has been infused.
	2) Press the LOCK soft key and verify the Lock indicator is illuminated. Press the UNLOCK soft key and verify the Lock indicator turns off.
	3) Press CHG RATE soft key and set a rate to the maximum rate available on the ml/hr control screen. Allow the unit to drive for the full length of the syringe. Verify the infusion stops with an empty syringe alarm.
	4) When the syringe is empty, verify the Syringe Empty alarm message is displayed and the red alarm indicator is illuminated. Verify the alarm tone quality. Press Alarm Silence key to silence alarm.
	5) If other alarms or system failures occur during this test use the troubleshooting guide for corrective actions.

Motor Drive & Occlusion Operational Test

Connect a three-way stopcock to an empty 50cc or 60cc luer-lock syringe. Load the syringe with the syringe filled with approximately 30cc of air. [*Note: use a new syringe for this test as the lubrication within syringes evaporates, change "test" syringes at least monthly.*]

	1) Select ML/HR mode and set the flow rate to the maximum rate as displayed on the ml/hr entry screen. From the Pause screen, press the BOLUS key to enter the PRIME screen. Press and hold the BOLUS key to prime the tubing set for at least 0.2 ml priming volume. Exit the prime screen. Close the stopcock to the syringe.
	2) Select OPTIONS, select OVERRIDE OCCL LIMIT, select HIGH and press ENTER.
	3) Select OPTIONS, Select DISABLE RAPID OCCL DETECT, if available. If not available, press BACK.
	4) Start the infusion.
	5) Verify the pump operates until an occlusion alarm occurs.

	Open the stopcock to release the pressure, then remove the syringe.
	6) If any alarm other than occlusion occurs during this test, see the troubleshooting guide for corrective action.

Flow Delivery Accuracy Test

Return the pump to the MAIN screen. Select ML/HR delivery mode. Select a syringe manufacturer. Load a 50/60 cc luer-lock syringe (air-filled) into the pump – use a syringe from the table below. Enter rate of 300 ml/hr. [*Note: use a new syringe for this test as the lubrication within syringes evaporates over time, change "test" syringes at least monthly.*]

	1) From the Pause screen, select OPTIONS and use number key to select VOLUME LIMIT. Enter a volume limit of 50 ml. (Note: if volume limit is not configured, then manually press the STOP key when TVD reaches 50.0 ml.) From the Pause screen, press the BOLUS key to enter the PRIME screen. Press and hold the BOLUS key to prime the tubing set for at least 0.2 ml priming volume. Exit the prime screen. Use calipers to measure the distance from the outside of the syringe flange to the inside of the syringe plunger. **Record this measurement as the starting position.**
	2) Press the start key and insure the pump delivery begins. Wait until the pump volume limit is reached in 10 minutes. (Manually press the STOP if volume limit is not active.) Press the alarm silence to silence the audible alarm. Use a set of calipers to measure the distance from the outside of the syringe flange to the inside of the syringe plunger. **Record this measurement as the ending position.**
	3) Subtract the ending position from the starting position. Verify that this result is between 3.473" and 3.615" (inclusive) for a B-D 60cc syringe, consult table below for other syringes.
	4) If this test fails use the troubleshooting guide for corrective action.

Manufacturer	*Minimum travel*	*Nominal travel*	*Maximum travel*
B Braun Perfusor 50cc	**3.146"** *(79.92mm)*	3.211" *(81.55mm)*	**3.275"** *(83.18mm)*
B Braun Ominifix 50cc	**3.146"** *(79.92mm)*	3.211" *(81.55mm)*	**3.275"** *(83.18mm)*
B-D 60cc	**3.473"** *(88.22mm)*	3.544" *(90.02mm)*	**3.615"** *(91.82mm)*
Fresenius 50cc	**2.904"** *(73.76mm)*	2.964" *(75.27mm)*	**3.023"** *(76.77mm)*
Monoject 60cc	**3.473"** *(88.22mm)*	3.544" *(90.02mm)*	**3.615"** *(91.82mm)*
Terumo 60cc	**2.901"** *(73.70mm)*	2.961" *(75.20mm)*	**3.020"** *(76.70mm)*

Table of acceptable syringe travel for 50 and 60 cc syringes.

AC Line Leakage Test	
	1) Connect the AC power cord to the Safety Analyzer. Set Safety Analyzer to Line Leakage mode of operation. Power on the pump.
	2) Using the ground reference probe of the Analyzer, make contact with either the plunger driver tube or the center post of the DC input jack. Verify the leakage in both the normal and reversed settings is less than 100 micro-amps [note, this is equivalent to BF rating for this device]. *If you wish to verify the CF rating of the pump, then fill a beaker with normal(0.9%) saline solution and load the pump with a syringe and tubing filled with normal saline. The saline-filled tubing should be in contact with the saline in the beaker. Place the ground reference of the leakage current Analyzer in contact with the saline in the beaker and verify the leakage current in both normal and reversed settings is less than 10 micro-amps. [This procedure is specified in IEC 60601-2-24, clause 6.]*
	3) Turn off pump and disconnect from safety analyzer.

Warning! Safety Class II, Type CF medical equipment	The pump is listed as Safety Class II, Type CF equipment. Protection against electrical shock does not rely only upon basic insulation, but instead relies on double or reinforced insulation. As such, this equipment does not utilize a third wire ground (earth ground). Therefore, when doing line leakage test it is not necessary to measure leakage in both the open ground and closed ground setting. Nor is it necessary to perform a ground resistance test.

Battery Maintenance

This chapter discusses battery maintenance as recommended to insure good battery performance.

1. The battery pack contains six 1700 mA-Hr Nickel Cadmium (NiCad) cells with a smart gauge for monitoring battery charge information. [Note: the gauge built into the battery pack, and the pump reads the battery capacity from the gauge on the pack.]
2. There are two measured battery parameters must be reviewed to maintain good battery performance and accuracy of the battery gauge. They can be accessed, by selecting Biomed *Diagnostics,* then MONITOR BATTERY STATUS option.
   a) LMD (Last Measured Discharge) – This the *learned capacity* of the battery by the gauge following a calibration cycle. It is recommended the battery be replaced when this value is < *1400 mA-hours.*
   b) CPI (Capacity Inaccurate) – This is the *number of shallow discharge cycles* since the last calibration. It is recommended that you recalibrate the battery when CPI is *> 80 hex (i.e. >128 decimal).* Refer to the battery calibration section below.

Shallow Discharge (CPI) Record

The battery gauge records the number of shallow discharges. A *shallow discharge* happens whenever the battery is *partially* discharged and then returned to AC power. The number of the shallow discharges appears on page two of the MONITOR BATTERY STATUS menu in the Biomed *Diagnostics* menu.

- This displays CPI as 0xDD, where 0xDD is a hexadecimal number representing the number of shallow discharges cycles.
- The value is reset to zero each time the battery is calibrated. It increments to a maximum count of 0xFF hex (255 decimal).

During the annual periodic maintenance if the number of shallow discharges, CPI, is 0x80 hex or higher [e.g. 0x90, 0xA5, 0xBB, etc.], then the battery should be re-calibrated.

Battery Calibration Procedure

The *battery calibration* procedure insures the battery calibrates (or "re-learns") the battery capacity. It does this by measuring the actual charge & discharge rates to determine the true capacity of the battery. With this correct information, the pump calculates "percentage of battery charge" and determines "low battery alarm".

1. Connect the pump to AC power.
2. Turn on the pump and select Biomed *Diagnostics* MONITOR BATTERY STATUS.
3. After the Charge Level gauge reaches 99 to 100%, wait at least 1 more hour, then remove AC power.
4. Using one of the methods listed here, fully drain the battery pack, until the pump sounds the BATTERY DEPLETED alarm (not the LOW BATTERY alarm). You can interrupt the discharge test by turning the pump OFF and continue discharge at a later time – as long as you do not plug the pump into AC power during the discharge cycle.
   a) The battery can be discharged by operating the pump on battery power and infusing at 5 ml/hr using a 60cc syringe. This takes approximately *10 hours* from a full charge.
   b) A quicker method is holding open the clutch lever with an a clamp or vise grips to prevent the plunger flipper and clutch from closing. Then use Biomed *Diagnostics* MOTOR DRIVE TEST, and set motor step period to 2 msec, and press the START key. This should deplete the battery within approximately *3 hours* .
   c) A third method is to disconnect AC power, turn ON pump, and run Biomed MONITOR BATTERY STATUS. This discharges the battery at about 130 ma, and takes approximately *13 hours* from full charge.
5. Once the BATTERY DEPLETED alarm sounds, turn OFF the pump and plug into AC. This begins recharging the battery. **[Do not unplug AC power until charging is complete.]**

   If left in "Depleted" alarm condition, the pump will draw power from the battery until its voltage drops to a level which disconnects the battery gauge. ***The pump then loses all its calibration information.***

From the time the BATTERY DEPLETED alarm occurs, the pump has approximately 5 minutes of operation on battery before the "fully-depleted disconnect" condition occurs. At this point, the audible alarm continues running from the super-capacitor on the main board.

6. After several minutes of recharging the gauge will show the learned capacity of the battery.
7. Turn on pump and select Biomed *Diagnostics*, MONITOR BATTERY STATUS.
8. Verify LMD (last measured discharge) value is greater than 1400 ma-hours.
9. Press the **More** button and verify CPI is 0x00 or 0x01.
10. Turn off pump and continue to charge pump until battery charge is complete (approximately 10 hours).
11. Turn on pump and select Biomed *Diagnostics* MONITOR BATTERY STATUS.
12. Verify the LMD is greater than *1400 mA-hours*. At 1400 mA-hours battery, the pump's battery life is approximately 7-8 hours. It is recommended that the battery be replaced if its capacity is less than 1400 mA-hours.

Requirements for Battery Pack Replacement

The battery must be replaced only by a trained Biomedical or service technician. Always dispose of depleted or defective batteries in compliance with all applicable regulations or you may return the battery pack to Medex for recycling.

Warning! Battery Replacement	Observe ESD handling precautions when replacing the battery. Replace battery only with same Medex part/model number. Recycle NiCad battery in compliance with applicable local regulations.

PART 2: THEORY OF OPERATION

This part of the manual contains definitions and descriptions of standard operation of the 3000 Series infusion pumps.

Technical Definitions

The following are technical definitions for the 3000 Series infusion pump.

Term	Definition
Class II	Equipment in which protection against electrical shock relies on double or reinforced insulation instead of basic insulation. Accessible metal components of pump enclosure use this higher level of insulation instead of safety grounding.
Type CF	Equipment in which level of protection from electrical shock is defined by leakage current (C) exposure and insulation by isolated or floating (F) metal of pump enclosure relative to earth grounding. Under normal conditions: • users are exposed to no more than *100 microamps* – when measured through the pump • and patients to no more than *10 microamps* – when measured through IV path.
Infusion Class 4	An infusion pump which combines the functions of continuous infusion flow, intermittent flow, and discrete bolus delivery.
Infusion Class 5	An infusion pump which functions as a profile pump, providing a programmed sequence of delivery rates.
IPX3	Equipment which is ingress protected from fluid spraying at vertical angle from above, and from angles to 60° on either side of vertical.
V ~	Symbol for operating voltage range for alternating current (*i.e.*, AC or mains) power source.
	Symbol for infrared serial communications port on pump.
	Symbol for external DC jack connection. Tip (negative sign) is for power ground and ring (positive sign) is for positive power connection.

Overview of Operation

The 3000 Series syringe pump design allows the precise control of the infusion rates over a wide range of syringe sizes and manufacturers as specified in the Operation Manual.

Controlling Motor Functions

A stepper motor driving the plunger driver controls the infusion rate. The motor receives electrical pulses from microcontroller with pulse frequency determined from the programmed flow rate.

- Forty-eight motor pulses turn the motor one full revolution.
- Five hundred and sixty full motor revolutions move the plunger driver one inch.
- Therefore, 26,880 motor steps move the plunger driver 1 inch (or 0.000037 inches per motor step) – providing very good flow continuity and precise delivery.

Infusion Control & Safety Functions

Two sensors are used to verify that the infusion proceeds at the programmed rate. Specifically, the microcontroller uses:

a) the *motor rotation sensor* to verify proper motor speed;
b) the *position sensor* to verify proper syringe plunger driver motion over time.

If the microcontroller determines either motor or syringe plunger driver is running at a speed not equivalent to the programmed flow rate, then the infusion stops and a system fault alarm warns the user.

Four additional sensors verify the syringe parameters:

a) The plunger sensor, in the head of the plunger driver, detects proper engagement of syringe plunger with syringe plunger driver.
b) The flange ear clip detects the proper position of the syringe flange.
c) The syringe barrel clamp detects both *syringe presence* and *syringe size.*
d) A force sensor in the plunger driver head detects and reports the amount of force exerted on syringe plunger head. A large amount of force indicates an occlusion in the patient line to the microcontroller.

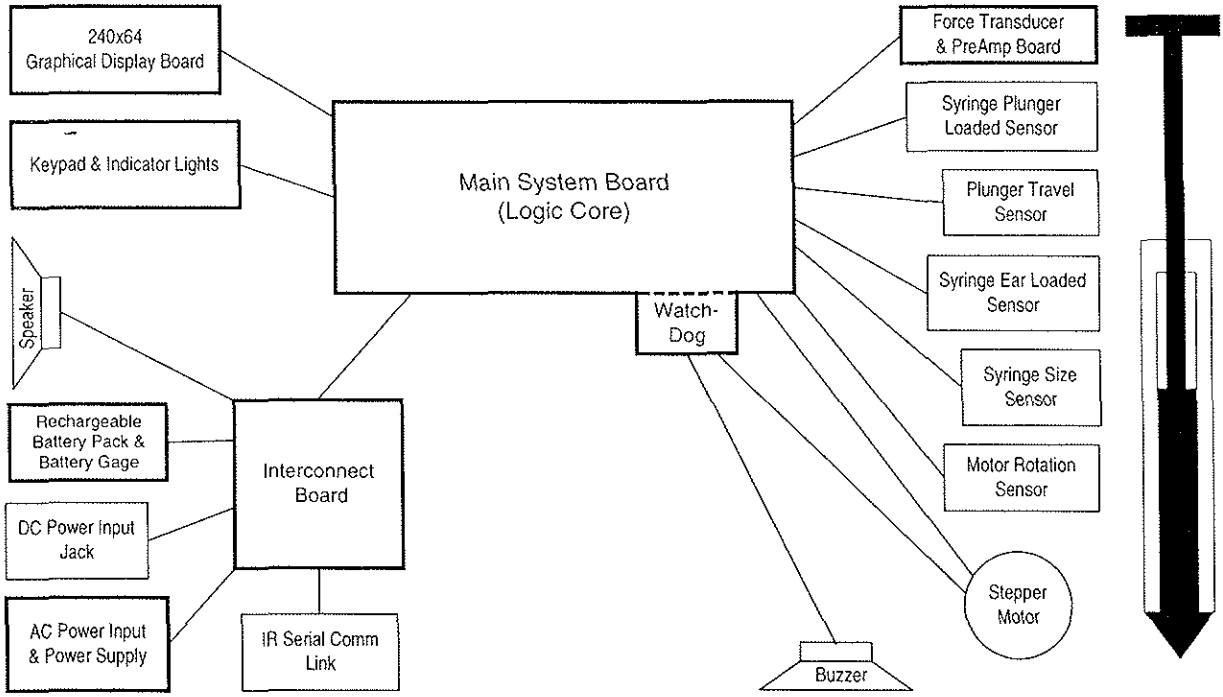
A Watchdog device checks for microcontroller malfunction including timebase errors, and can shutdown the motor and generate an alarm independent of the microcontroller operation. An internal power source (*i.e.*, 1 Farad super-capacitor) allows the pump to alarm should failure occur in the pump's power system or internal battery.

Pump Design Description

Listed in this chapter are descriptions of each functional block and its role in pump operation and system safety.

Logic Core of 3000 Series Pumps

The block diagram below shows interrelation between the different assemblies of the 3000 Series syringe pump.



Block Diagram for 3000 Series Infusion Pump

Main Circuit Board

Main Microprocessor

The *main circuit board* has one main microprocessor, 68HC11, with responsibilities for the following tasks:

a) Controlling the graphical display of information.
b) Responding to the keypad and controlling visual indicators on the keypad.
c) Controlling the primary speaker.
d) Controlling the stepper motor which drives the syringe plunger.
e) Monitoring syringe sensors: syringe size, syringe flange (ear) loaded, syringe plunger loaded, syringe plunger position, and syringe plunger force.
f) Communicating with the smart battery gauge.
g) Controlling the external serial communication.

Watchdog Circuit

A *watchdog circuit* has a separate power supply and separate (PIC) microcontroller/clock which monitors the main microprocessor. The watchdog circuit detects microprocessor timing failures and initiates a watchdog alarm through a dedicated "back-up" audible alarm which is separate from the primary speaker.

If a watchdog or "SYSTEM FAILURE" alarm is generated, then watchdog circuit turns on the red alarm indicator and backup audible alarm, and turns off the motor current.

DC Power Converter

The *DC Power Converter* generates required system DC voltages from the available power source coming from the interconnect board. This power source can be either battery power, or AC power, or external DC power. The main microprocessor monitors these voltages and will detect failures in any system voltages.

Real Time Clock

A separate *Real Time* clock source provides the microprocessor with date and time information. The date and time are used for time-stamping records in alarm history and infusion history, and for determining the next recommended Periodic Maintenance date.

Graphical Display Circuit Board (LCD)

A 240 x 64-pixel *liquid crystal display* provides the primary visual interface for pump operation.

- An *always on* LED driven back light in the LCD enhances viewing in low light areas.

Keypad

The *keypad* is a multi-layer polyester laminate providing buttons for controlling the pump, and indicator lights for identification of pump status.

Plunger (Driver) Travel Sensor

The *plunger travel sensor* is a precision potentiometer producing a change in voltage (resistance) with the motion of the syringe plunger driver. This allows the microprocessor to determine:

- plunger speed
- near end of plunger travel (i.e,. near empty alarm)
- end of plunger travel (i.e., empty alarm)

The microprocessor uses sensor output to verify plunger travel against set flow delivery rate. The sensor output is not used for rate correction.

Motor Rotation Sensor

The *motor rotation sensor* is an optical reflective sensor which senses 4 pulses per motor rotation. The microprocessor measures the frequency of this signal to:

- Verify rotation speed against the set flow delivery rate. It is not used for speed correction.

Stepper Motor

The *stepper motor* drives the syringe plunger driver.

- Each motor step is controlled by the microprocessor using an open loop control method.

Syringe Flange Loaded Sensor

The syringe ear or *syringe flange sensor* requires the flange be installed in the flange locating device on the pump.

- Reports a logic state to the microprocessor to indicate proper syringe flange loading.
- Uses self test signal to verify the sensor is not in an electrically "stuck" state.

Syringe Size Sensor

The *syringe size sensor* is a precision potentiometer which produces a voltage (resistance) proportional to the outside barrel diameter of the syringe loaded into the pump. This allows the microprocessor to measure:

- Voltage proportional to syringe barrel outside diameter to determine the syringe size (e.g. 10cc, 20cc etc.) or syringe not loaded.

Interconnect Printed Circuit Board

Receives and directs the power source, either internal 12VDC power supply, internal battery, or external DC power to the "Main" board.

a) Generates status signals to "Main" board indicating source of power supplied.

b) Contains battery charger for charging the battery.

c) Contains an infrared drivers for serial communication interface with the pump.

d) Supplies the audio drive signal, originating from the "Main" board, to power the speaker.

AC Power Input & Power Supply Board

This *AC Power Input* provides a receptacle for connecting an IEC 320-type AC power cord to the internal, universal input power supply. This *Power Supply Board* provides 12 VDC to operate the pump and charge the batteries.

DC Power Input Jack

The *DC Power Input Jack* connects external DC power into the pump from external DC sources. This input is protected from over-voltage and reverse polarity.

- Always observe all cautions and warnings for connecting DC power to this input.

Speaker

The primary *speaker* serves as the primary audio source for generating alarms.

- The microprocessor senses speaker current to determine if speaker is operational.

Rechargeable Battery Pack & Battery Gauge

A *rechargeable NiCad battery pack* allows operation on battery, which also serves to provide backup power with the loss of externally applied AC or DC power

A gauge residing on the battery pack maintains present battery capacity during charge and discharge conditions. The gauge monitors battery temperature and controls the battery charger in setting the charge rate. The pack contains a resettable fuse which limits the current flowing through the battery.

Plunger Printed Circuit Board

This *plunger printed circuit board (PCB)* provides connection and pre-amplification of sensors in the plunger driver to the main microprocessor board. The plunger PCB contains the force sensor amplifier and the plunger loaded sensors.

Plunger Force Sensor

The *plunger force sensor* is a full bridge strain gauge which generates a voltage proportional to the force applied by the plunger driver to push the syringe plunger. The allows the microprocessor to measure:

- Voltage proportional to force applied to the syringe plunger (i.e. occlusion detection).
- Uses self test control line to verify force sensor and circuitry are operating properly.

Plunger Loaded Sensors

The two *plunger loaded sensors* are located on the plunger PCB, and sense the state of each "flipper" on the plunger driver.

- Reports a logic state to the microprocessor to indicate proper syringe plunger loading.
- Uses self test signal to verify the sensor is not in an electrically "stuck" state.

Main Board – Schematic Level

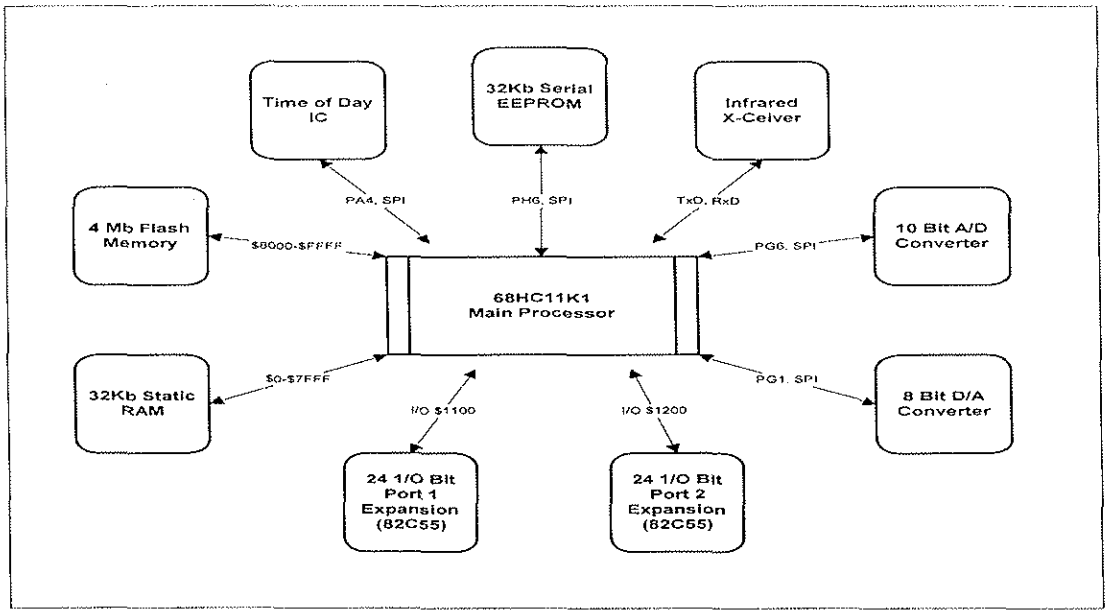
The Main printed circuit board design has the following sub-circuits:

- *Logic Kernel*
- *Power Control*
- *DC-DC Converter*
- *Front Panel Interface*
- *Graphic Display Interface*
- *Motor Drive*
- *Motor Speed Detection*
- *Syringe Sensing*
- *Plunger Position Sensing*
- *Force Sensing*
- *Speaker Drive*

Each of the sub-circuit descriptions is presented in the order of the schematic pages of the **Series 3000** "Main Printed Circuit Board". The signal names marked with the asterisk symbol on the schematic indicate that those signals are "active-low".
In the block diagrams for each section, the arrows indicate data flow direction referenced to the main microprocessor. In some cases, the arrows will identify a device other than the microprocessor to which the signal directly interfaces, (*e.g.*, analog to digital converter).

Logic Kernel Description

The **Series 3000** Logic Kernel Main PC flowchart is below. It shows linkage between the 68HC11K1 microprocessor and the main components of the system:



Flowchart of Logic Kernel for 3000 Series infusion pump

68HC11K4 Main Microprocessor Interface, U-19

The main microprocessor's direct signal interfaces are described in clockwise order taken from the **Series 3000** Main PC Schematic of the microprocessor. The following table summarizes some of the microprocessor input / output signals.

Signal Name	Processor Port	Description

IR_XMT_DATA	PD1/TxD	The IR_XMT_DATA is used for transmitting asynchronous serial data.
IR_RCV_DATA	PD0/RxD	The IR_RCV_DATA is used for receiving asynchronous serial data.
SPEAKER_FREQUENCY	PH0/PW1	Sets the audio frequency of the main speaker. Generated as a fixed 50% duty cycle (square wave) with a variable frequency.
SPEAKER_VOLUME	PH1/PW2	Fixed frequency variable pulse widths signal that the speaker-driver hardware converts into a DC voltage for volume control.
MTRPHA_IREF	PH2/PW3	Pulse-width modulated output transformed by hardware into a DC level representing motor current for coil "A" of the motor.
MTRPHB_IREF	PH3/PW4	Pulse-width modulated output transformed by hardware into a DC level representing motor current for coil "B" of the motor.
ADC_CS*	PG6	Chip select signal for SPI communication to the 10-bit analog to digital converter. This signal is active low.
DAC_CS*	PG1	Chip select signal for SPI communication to the 8-bit digital to analog converter. This signal is active low.
RESET_PIO	PG0	Allows the main processor to independently reset the two 24 bit I/O expansion devices. The reset is active high.
POWER_STROBE	PD5	Controls the power state of the system. Must be an AC signal to maintain the power on state. A stuck state of either logic high or low, is one of the conditions for enabling the power off state.
PLUNGER_DETECT1	PA6/OC2	Logic sense signal for detecting the respective plunger flipper state. A logic high indicates a syringe is loaded.
PLUNGER_DETECT2	PA5/OC3	Logic sense signal for detecting the respective plunger flipper state. A logic high indicates a syringe is loaded.
ACU_PWR_STRB_ON	PA4/OC4	This feedback signal to check that ACU is still controlling power to the system. When power is on, ACU_PWR_STRB_ON measures > 4.0 volts nominally.
ASYNC_BATTERY_DATA	PA3/IC4/OC5	The single wire asynchronous data communication between the main processor and the battery gage located on the battery pack. This port pin is bi-directional, both input & output.
IO_CS*	CSIO	Chip select for the two 24 bit I/O expansion devices. This signal is active low.
RAM_CS*	CSGP1	Chip select for the main processor's external random access memory (RAM). This signal is active low.
EEPROM1_CS*	PH6	Chip select for SPI communication to the serial E^2 PROM #1. This signal is active low.
FLASH_CS*		Chip select for access to the main processor's programmed memory (FLASH). This signal is active low.
WRITE*, E_CLOCK, XADDR[15:18], ADDR[0:14], DATA[0:7]	R/w*, E, XADDR15 - XADDR18, ADDR0 - ADDR14, and DATA0 - DATA7	The main processor control bus signals that route to the memory and I/O expansion devices. The address line ADDR15 is not used.
SPI_CLOCK, SPI_MOSI, and SPI_MISO	SCK, MOSI, MISO	These signals are used for SPI bus communication to the Serial EEPROM, Time of Day Clock, Analog to Digital Converter, and the Digital to Analog Converter.
ATOD_REF_BFRD	AN0	Input for main processor to verify the reference voltage used by the 10-bit analog to digital converter and system reference. The nominal measured reference voltage is 2.048 volts.

Signal Name	Processor Port	Description

SUPERCAP_DETECT	AN1	Analog signal proportional to the Super Capacitor voltage. When fully charged, SUPERCAP_DETECT measures 2.5 volts nominally. The main processor read SUPERCAP_DETECT to verify the Super capacitor is present.
PWR_STRB_ON	AN2	Feedback signal is to check the proper operation of the power control circuit. When power is on, PWR_STRB_ON measures > 4.0 volts nominally.
MOTOR_SPLY_MEAS	AN3	Signal is proportional to the motor supply voltage. The nominal dc voltage for this signal is 1.09 volts, exactly a sixteenth of the motor supply voltage.
ANALOG_SPLY_MEAS	AN4	Signal is proportional to the analog supply voltage. The nominal dc voltage for this signal would be 2.5 volts nominally, exactly one half of the analog supply voltage.
FORCE_OSV_ADJ	AN5	Feedback signal proportional to the offset voltage used on the force sensor pre-amplifier. Its voltage range dependent upon the offset voltage setting (a calibration value).
SPEAKER_DETECT	AN6	Feedback signal proportional to the current through the main speaker. Its level depends on the volume setting for the speaker.
VPOS_SPLY_MEAS	AN7	Signal is proportional to the positive supply voltage. The nominal dc voltage for this signal is 2.397 volts, exactly one fourth of the VPOS_SPLY supply voltage.
MTR_TIMER	PA7/OC1	Time base used by the main processor to control motor step timing and an input to the highest, maskable interrupt source.
MOTION_DETECT	PA2/IC1	Signal is the encoded output from the optical motor rotation detector.
BUZZER_DETECT	PA1/IC2	Feedback signal from the audio buzzer detection circuit. This signal is logic high whenever the audio buzzer is active.
TOD_INTRPT	PA0/IC3	An independent time base provided by the time of day clock. This is a 1 Hz frequency signal.
	MOD_A, MOD_B	These inputs configure special processor operational modes.
RESET*	Reset	Provided from the system-reset circuit located in the Power Control Logic section of the Main PCB.
	VRH	4.096V A/D reference
	AVDD, AVSS, and VRL	The main processor's analog to digital conversion supply and reference pins.

Flash Memory, U-22

Flash program memory is 512 K x 8. It is addressed as 16 pages of 32 K x 8 each.

Flash memory can be reprogrammed within the system.

Software Upgrade Method for Programming Flash Memory

The re-programmable feature of Flash Memory provides for software upgrades. The pump is placed in a special Biomed mode which allows reprogramming of the software through the infrared serial port.

Static Random Access Memory, U-17.

Static RAM is 32 K x 8 bit.

Serial EEPROM, U-2 and U-4

There are two, 8K x 8 bit (future 16K x 8bit) serial EEPROMs used for storing manufacturing, calibration, configuration, libraries, and service data requiring non-volatile random access.

Time of Day, U-8

The time of day, including calendar, is maintained by the RS5C316B which is continually powered as long as AC, external DC voltage, or internal battery is present, or the super capacitor is charged.

Infrared Transceiver

An IR transceiver, located on the Interconnect board, provides an electrically isolated asynchronous serial communication link between the pump and an external system. The infrared link is intended for short distances of less than a few inches.

Analog to Digital Converter, U-13

A four channel, unipolar, 10-bit converter obtains high resolution analog measurements.

The high resolution measurements in ascending channel order are:

- *pressure sensing amplifier*
- *plunger force sensing amplifier*
- *syringe size sensing amplifier*
- *plunger travel sensor.*

The converter uses precision 4.096-volt reference equating to a bit resolution of *4 millivolts*. The converter interfaces to the Serial Peripheral Interface of the 68HC11.

Digital to Analog Converter, U-20

A dual channel 8 bit *digital-to-analog* converter:

- Generates the contrast voltage for the Liquid Crystal display,
- Generates an offset to the force sensing amplifier.

Uses precision 4.096-volt reference equating to a nominal bit resolution of 16 millivolts. Channel A is the source for the force amplifier, and channel B is the contrast voltage reference.

I/O Port Expansion, U-3, U-33

There are two 82C55 input/output port devices providing the additional input/output requirements for the microprocessor. They are accessed through the I/O chip selects PORT1_CS* and PORT2_CS*.

Expansion Port # 1 (PORT1_CS)

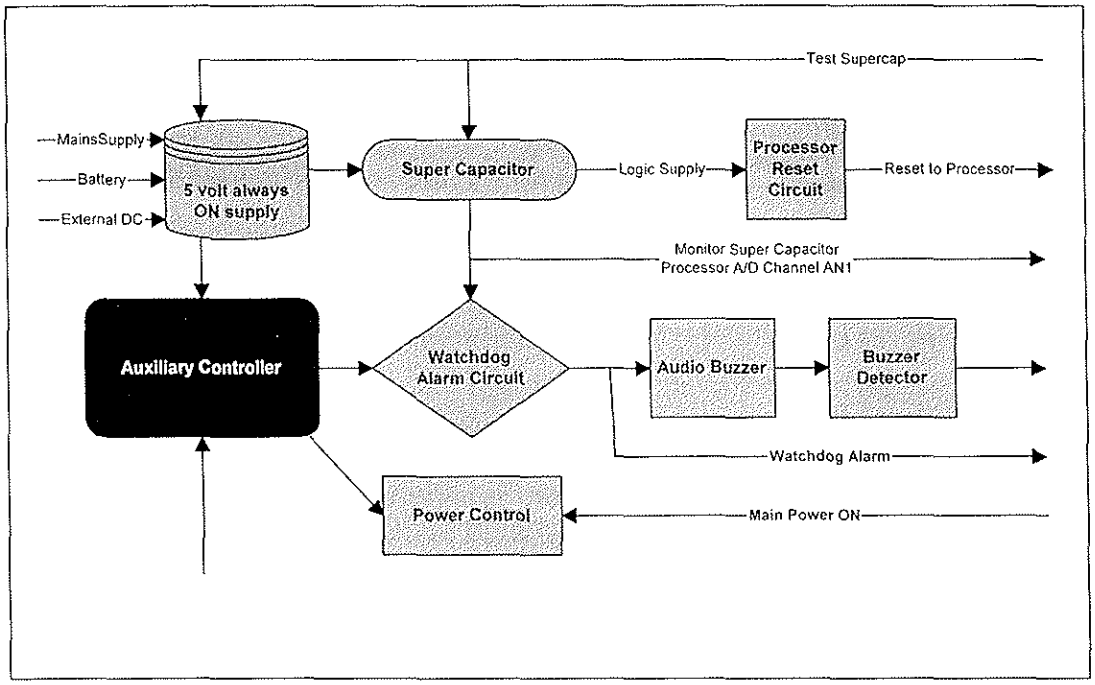
Signal Name	Port Location	Description
EEPROM2_CS*	PB7	A logic low enables accessing the 2nd serial EEPROM.
PET_WATCHDOG	PB6	A logic signal used as a handshake for indicating valid operational status to the auxiliary controller.
SUPERCAP_TEST	PB5	A logic high enables testing the super-capacitor, (*i.e.*, backup power source).
TOD_CS	PB4	A logic high enables accessing the time of day IC.
TOD_WR_ENBL*	PB3	A logic low enables writing data to the time of day IC.
SPEAKER_ENVELOPE3	PB2	A logic high selects the audio envelope time constant of 35 milliseconds. Refer to the Main Speaker Drive description section.
SPEAKER_ENVELOPE2	PB1	A logic high selects the audio envelope time constant of 11 milliseconds. Refer to the Main Speaker Drive description section.
SPEAKER_ENVELOPE1	PB0	A logic high selects the audio envelope time constant of 2.5 milliseconds. Refer to the Main Speaker Drive description section.
WARNING_LED_ON*	PC7	A logic low turns the "Caution" LED indicator on.
INFUSING_LEDL_ON*	PC6	A logic low turns the left most (when viewing the keypad) "Infusing " LED indicator on.
INFUSING_LEDM_ON*	PC5	A logic low turns the middle "Infusing" LED indicator on.
INFUSING_LEDR_ON*	PC4	A logic low turns the right most "Infusing" LED indicator on.
PCELL_LED_ON*	PC3	A logic low turns the "Pressure Cell" LED indicator on.
BATTERY_LED_ON	PC2	A logic high turns the "Battery" LED indicator on.
CAUTION_LED_ON*	PC1	A logic low turns the "Caution" LED indicator on.
LOCKOUT_LED_ON*	PC0	A logic low turns the "Tamper Feature Active" LED indicator on.
KEYPAD_IN_COL(0-5)	PA0-PA5	Senses 1 of 6 columns of the keypad matrix. When the sense value is logic low, the indication is the corresponding button for the column is being pressed.
PWR_SW_MCU	PA6	Sense signal for the power switch. The signal is at a logic high when the power switch is being pressed.
MTR_CURRENT_DETECT*	PA7	Sense signal from the motor current detector circuit. If the motor is energized with sufficient current in any coil, this signal is at logic low.

Expansion Port # 2 (PORT2_CS)

Signal Name	Port Location	Description
SET_IN_SNSR_ENBL*	PB6	Set to logic low to enable the "set in" detector to sense the pressure cell being installed.
SYRINGE_EAR_SNSR_ENBL	PB5	Set to logic high to enable the "syringe" detector to sense the syringe (ears) being installed.
PLUNGER_SNSRS_ENBL	PB4	Set to logic high to enable the "plunger" detectors to sense the plunger flippers being properly engauged.
MOTION_SNSR_ENBL	PB3	Set to logic high to enable the motion sensor monitoring the motor speed.
FORCE_SNSR_TEST*	PB2	Set to logic low to activate the force sensor test circuit. This signal causes the sensor to generate a known offset if the sensor is operating properly.
PRESSURE_SNSR_TEST*	PB1	Set to logic low to activate the pressure sensor test circuit. This signal causes the sensor to generate a known offset if the sensor is operating properly.
LCD_RESET*	PB0	Allows the main processor to reset the LCD display independently of other system devices. The reset signal is active low.
MTR_PHB_DIR	PC7	Controls the direction (phase) of motor current in coil "B" of the stepper motor.
MTR_PHB_ENBL*	PC6	Set to logic low to enable motor current in coil "B".
MTR_PHA_DIR	PC5	Controls the direction (phase) of motor current in coil "A"of the stepper motor.
MTR_PHA_ENBL*	PC4	Set to logic low to enable motor current in coil "A".
KEYPAD_SEL_ROW3*	PC3	Control signal to select row 4 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
KEYPAD_SEL_ROW2*	PC2	Control signal to select row 3 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
KEYPAD_SEL_ROW1*	PC1	Control signal to select row 2 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
KEYPAD_SEL_ROW0*	PC0	Control signal to select row 1 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
BUZZER_ARMED	PA0	A logic high indicates the backup audio buzzer is ready to alarm should the "watchdog" alarm state become true. A series resistor is provided to prevent latching.
WATCHDOG_ALARM	PA1	A logic high indicates the "watchdog" alarm state is true.
EXTRNL_PWR_DETECT	PA2	A logic high indicates an external power source is connected to the pump. A series resistor is provided to prevent latching.
AC_PWR_DETECT	PA3	A logic high indicates AC line power is connected to the pump. A series resistor is provided to prevent latching.
SYRINGE_EAR_DETECT	PA5	A logic high indicates the syringe ears are installed properly in the pump and SYRINGE_EAR_SNSR_ENBL is active.
SET_IN_DETECT	PA6	A logic high indicates the pressure cell is installed and SET_IN_SNSR_ENBL is active.
VLOW_BATTERY	PA7	A logic high indicates the battery voltage has fallen below a fixed voltage level, independent of the battery being charged.

Power Control Description

The power control logic provides two functions, power management, and triggers alarms when the main microprocessor fails. Refer to the Power Control Logic section of the Main PC Schematic for details.



Flowchart of Power Control Description.

Always On Supply, U-7

A 5-volt linear regulator provides power to the time of day clock and auxiliary controller, while maintaining a charge on the super capacitor.

- This supply is always active provided a power source is present be it the regulated mains AC power, battery, or external DC.

Backup Super Capacitor, C-11

This device provides backup power to the audio buzzer in the loss of the primary power source, a *1 Farad Super Capacitor* is part of the power control design.

- The super capacitor voltage SUPERCAP_DETECT, is monitored through the microprocessor's A/D converter channel by the microprocessor asserting SUPERCAP_TEST when the pump is turned on.

Backup Audio Buzzer, XD-1

The audio buzzer provides a means to generate a backup audible alarm during:

- *instrument power loss* (while the instrument was on)
- *malfunction of the main microprocessor*
- or *failure of the primary speaker.*

The audio buzzer is enabled when the pump is turned on, and when the WATCHDOG_ALARM signal activates. The WATCHDOG_ALARM signal (from the auxiliary controller) activates anytime there is a malfunction of the main microprocessor. The main microprocessor can activate this buzzer indirectly by not providing the PET_WATCHDOG strobe to the auxiliary controller which causes a watchdog alarm.

- During power-up, the buzzer is tested by the watchdog alarm state being active, and the buzzer response verified through the BUZZER_DETECT signal.

System Reset, U-43

On startup, the microprocessor comes out of reset when the logic supply exceeds 4.6 volts plus the built-in delay of the reset IC.

Power Management, U-39

An embedded Auxiliary controller oversees the power control management, and serves as the main microprocessor watchdog. The behavior of the power management system depends on pump states:

- *Power Off*
- *Power On*
- *Watchdog Alarm*
- and a *Battery Disconnect.*

Power OFF State

You must press, hold, and release the power switch to turn OFF the power. In normal operation, both the auxiliary controller and the main microprocessor control power-off.

Power ON State

To enter the *power on* state the POWER_ENBL signal is initially set active by the auxiliary controller. This requires the auxiliary controller provide an AC strobe to the POWER_ENBL circuit. This POWER_ENBL signal also arms the backup audio buzzer. The POWER_ENBL signal is verified by the main microprocessor monitoring the BUZZER_ARMED signal.

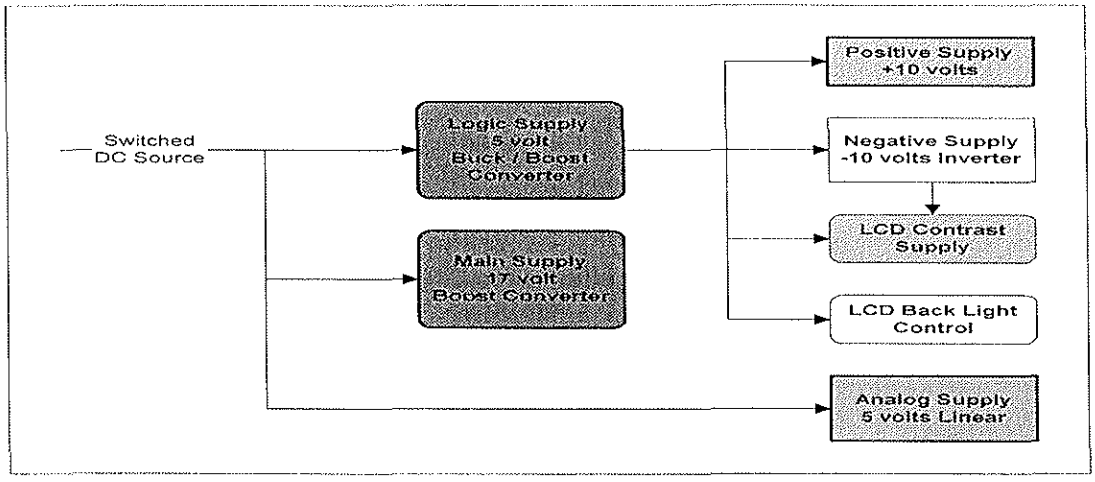
Watchdog

During a watchdog alarm, the auxiliary controller has sole control of power-off.

DC to DC Converter

The circuits for the DC-DC Converter provide all regulated voltages required by the hardware sub-circuits.

- A switched DC source, (battery, regulated mains supply, or external DC) powers the converter section under the control of the Power Control circuitry.
- The converter design provides stable supply operation from an unregulated DC source, simplifying the requirements for the switched sources.
- Refer to the DC-DC Converter section of the Main PCB schematic for details.



Flowchart of DC & DC Converter Operation

Logic Supply, U-12

The Logic Supply current-mode switching regulator provides a regulated output voltage of 5 volts (±5%) for the system logic.

Motor Supply, U-34

The Motor Supply is a current-mode switching regulator provides a regulated output voltage of *17 volts* for the motor current regulators.

Analog Supply, U-21

The Analog Supply is provided specifically for low noise signal processing circuits. Being a linear supply, inherent noise rejection removes source input switching noise from it's regulated output.

Positive & Negative Supply, U-36

The negative supply is a charge pump DC-DC converter doubles the input voltage, then inverts the doubled voltage.

- Provides the contrast voltage to the graphic LCD display. The low current load for the contrast voltage allows use of an operation amplifier controlled by the D/A converter through the SPI bus.
- Provides negative supply for the amplifiers used in force and pressure sensing.
- The charge pump doubles the "Logic Supply" voltage to achieve a *10V nominal positive supply voltage*. This supply is used for analog circuits needing a supply voltage higher than the "Analog Supply".

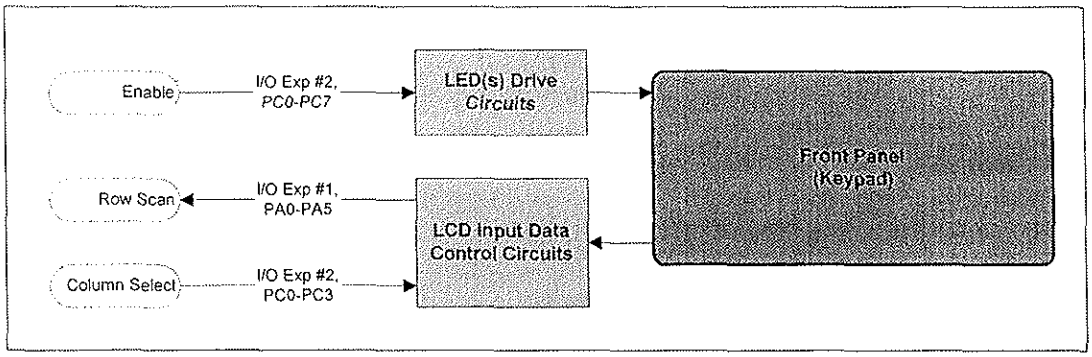
LCD Back Light Supply, U-1

A constant current regulator controls the primary LED back light for the LCD display. On the 3500 pump, the secondary LED for the backlight is controlled by Q45.

Front Panel Interface Description

The keypad interface has two circuits:

- the interface to the LED's
- the interface to the keypad switch matrix, and power switch.



Flow Chart of Front Panel Function

LED Drive Circuit, Q-26, Q-27, Q-40, Q33-Q37

Each LED drive circuit has a logic controlled switch providing a pseudo-current source to the LED when activated.

- All LED's except the "Warning", "Battery Charge", and "AC Power" LEDs, are controlled exclusively by the main microprocessor.

Keypad Matrix Interface

A 4 row by 6 column scan matrix senses the front panel keys:

- A pressed button is read from column signals, KEYPAD_IN_COLX, through the 82C55 port expander #1. A button press is sensed as a logic low.
- The keypad row signals are output from port C of the 82C55 port expander #2.

Power Switch Interface

The power switch has a circuit separate from the keypad matrix because it is monitored by both the main microprocessor and the auxiliary controller.

Graphic Display Interface Description

The graphic display interface circuits have the main microprocessor control signals, read write, the device select signal LCD_CS*, a data output latch, a data input buffer, and a device reset.

Data Output to LCD, U-32 / Data Input from LCD, U-6

The data from the LCD to the main microprocessor is buffered by U-32 and U-6.

LCD Contrast

The contrast control is created from the 8-bit digital to analog converter buffered with a 2.5 gain amplifier to provide minus contrast voltage.

- The full scale range of 255 (FF hexadecimal) counts equals approximately *minus 10 volts.*

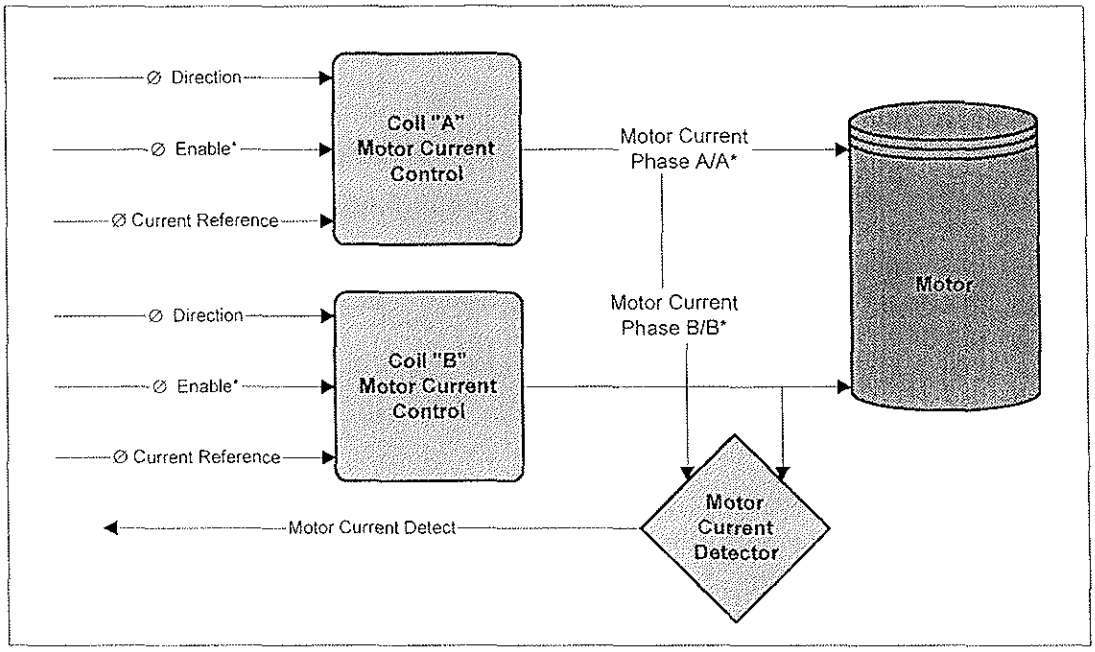
LCD Back Light

The primary *back light* for the LCD is an LED driven by a constant current source. This back light is *always ON* whenever the pump is ON.

The secondary backlight is not present on 3010 and 3010a pumps. Its on-off state is controlled by the CPU. During normal conditions, it is off when the pump is powered via the internal battery.

Motor Drive Description

A two-phase bipolar stepper motor drives the syringe plunger. The motor control interface drives the stepper motor.



Flowchart of Motor Drive Description

The main microprocessor controls which motor winding is active, designated as A or B, the direction of current in each winding, and the magnitude of the current.

Coil A & B PWM Current References

The pulse-width modulated signals from the main microprocessor are low pass filtered to create an analog voltages for control of motor current in each coil.

Motor Current Regulators, U-26, U-35

Two regulator ICS independently regulate the current for windings A and B.

- The watchdog_alarm signal activates the N-channel MOSFET to disable the motor current in both windings through the "BRAKE" pin of the regulator IC.

Motor Current Detector, U-40

The watchdog alarm function is tested at power-up by verifying the MTR_CURRENT_DETECT* signal is at a logic high when the watchdog alarm condition is active.

- Similarly, the MTR_CURRENT_DETECT* signal should be at a logic low when either motor winding has sufficient current and the watchdog alarm condition is not present.

Sensors Interface Description

Motor Speed Detection

The digital sense signal is created by using a reflective infrared optical sensor to sense a motor-coupled encoder as the motor rotates. The microprocessor measures the period of the signal created by the encoder.

Syringe Sensing Description

The syringe sensing system senses the syringe barrel size, senses the plunger end cap is secured by the mechanical flippers, and the syringe flange (ears) are located in the pump's syringe flange locating device.

- The circuit for sensing the plunger flippers is part of the plunger printed circuit function.

Syringe Size Sensing

Syringe sensing is accomplished by using a potentiometer which changes its resistance with the barrel diameter. The potentiometer is excited with a precision 4.096v voltage reference and the potentiometer's output is monitored through channel 2 of the system A/D.

- The sensing system requires calibration to determine offset and gain. Calibration values are stored in non-volatile (serial EEROM) memory.

Syringe Flange (Ear) Sensing

Syringe flange (or ear) sensor is used to detect if the syringe flange is installed in the flange-holder on the side of the pump.

An infrared optical interrupter detects when the flange-locating device is in a valid position. A properly loaded flange causes the optical path to become uninterrupted allowing a direct path from the infrared emitter to the detector.

- The emitter is enabled by the signal SYRINGE_EAR_SNSR_ENBL when set to logic low.
- The sensor output, SYRINGE_EAR_DETECT, produces a high logic state when the flange is properly loaded.
- The state should be logic low anytime the syringe ear (flange) is not installed or SYRINGE_EAR_SNSR_ENBL is inactive.

Plunger Position Sensing Description

Sensing syringe plunger position is required for the detection of an incorrect plunger speed, detecting near end of plunger travel, and detecting end of plunger travel.

The travel sensing circuits perform excitation and signal processing of the travel sensor. The travel sensor uses a *linear potentiometer* which produces a change in resistance with the motion of the syringe plunger.

- The sensing system requires calibration to determine offset and gain. Calibration values are stored in non-volatile (serial EEROM) memory.

Speaker Drive Description

The speaker sounds the warning and caution alarm tones for the pump. The interface circuit controls the frequency and amplitude of the signal driving the speaker, and provides feedback for verifying speaker function.

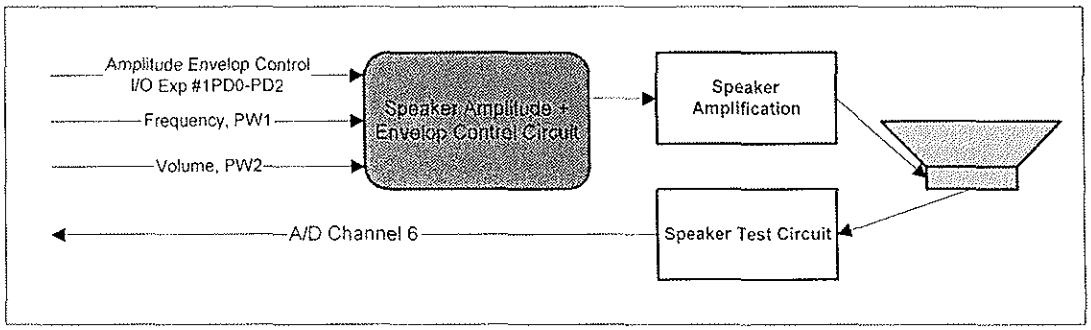


Illustration of Speaker Drive

Speaker Control

- Tone duration is controlled by the interval the amplitude level is applied.
- The SPEAKER_FREQUENCY signal is a fixed 50% duty cycle (square wave) with a variable frequency to *1 kHz*.
- The SPEAKER_VOLUME is a pulse-width modulated signal converted by hardware to an analog voltage which controls the speaker volume.
- The rise and fall times of the volume are controlled by input signals from: SPEAKER_ENVELOPE_1, SPEAKER_ENVELOPE2, and SPEAKER_ENVELOPE_3.

Speaker Test

The return signal from the speaker detects whether current is flowing in the Speaker from analog conditioning circuitry. The half-wave rectifier circuit uses the *negative half-cycle* of the sense signal to invert and amplify it.

- The amplified output is demodulated by the analog switch which creates a peak and hold circuit.
- The SPEAKER_DETECT output signal from the conditioning circuitry goes to the microprocessor's analog input.

Plunger Board – Schematic Level

The plunger PCB provides pre-amplification of the force sensor output to the Main system PCB, and contains two photo-interrupters with supporting circuitry, one for each plunger flipper.

The referenced schematic signals of the main board electronics are identified using names in SMALLCAPS.

Force Preamplifier Function

The force sensing system provides a measurement of the force required in moving the syringe plunger. The interface to the force sensor has an excitation source, test signal, and pre-amplification.

- The Main printed circuit board provides a fixed 4.096-volt excitation to the force sensor.
- The Main printed circuit board trims this offset range using the signal FORCE_PREAMP_OSADJ.
- The Main PCB provides additional gain to maximize measurement resolution.

Force Sensing Interface Description

The force sensing element is a full bridge strain gage, and the plunger PCB pre-amplifies and filters the output of this bridge. The interface has: *sensor excitation, electronic zero-offset adjustment, amplification and filtering, and a sensor test control signal*

- FORCE_SNSR_EXH provides a constant voltage excitation of *4.096 volts DC* to the sensor.
- Auto-Zero Adjustment Circuit provides a voltage to zero the pre-amplifier, FORCE_OSV_ADJ, from the 8 bit system D/A converter.
- Sensor Post Filter Amplifier is a second order low-pass filter with a 3.68x gain.
- The signal FORCE_SNSR_TEST* when set active low causes Q2 to apply a resistance parallel to the force sensor's bridge resulting in a positive shift of the sensor output.
- The sensing system requires calibration to determine zero adjustment, offset, and gain. Calibration values are stored in non-volatile (serial EEROM) memory.

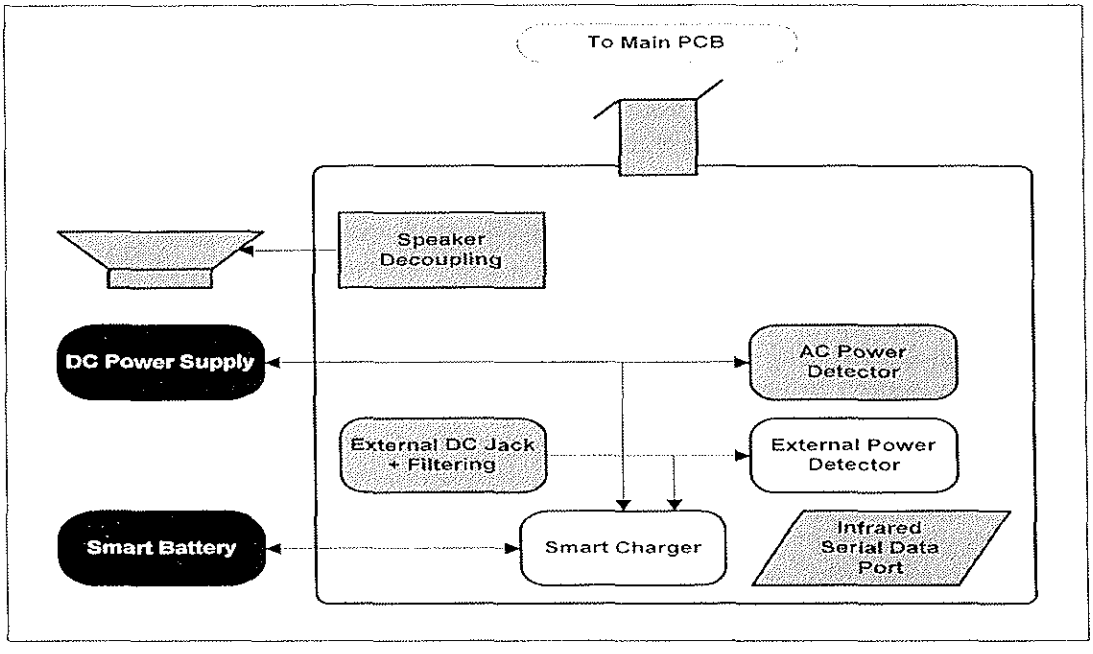
Plunger Flipper Sensor Function

Plunger flipper sensing requires each sensor detect its respective flipper position. Each infrared optical interrupter provides a high logic state when the flipper is in a valid position determined by a loaded syringe plunger. The transmitters for both photo-interrupters are driven in series; however, the optical receivers are read in parallel.

- Output from each *photo-interrupter* is monitored individually so each sensor is independently checked.
- When a syringe plunger is correctly loaded, both PLUNGER_SNSR1_OUT and PLUNGER_SNSR2_OUT are at a *logic high*.
- The transistor Q1 allows the sensor output to be tested by turning the transmitter from both sensors on and off. This is controlled by the signal PLUNGER_SNSRS_ENBL from the Main PCB.

Interconnect Board – Schematic Level

The interconnect printed circuit design interfaces to an intelligent rechargeable Battery, the system speaker, the internal DC supply, connection for an external DC supply and the main PCB.



Flowchart of Interconnect Board at Schematic Level

Each sub-circuit description is presented in the order of the schematic pages of the **Series 3000** "Interconnect Printed Circuit".

AC Power Detection Description

The AC power detector uses a *zener diode regulator* to provide a constant voltage to the signal AC_PWR_DETECT *anytime AC power is provided to the pump.* The regulated voltage is required for logic detection of AC power and is used to regulate the current through the AC LED indicator and the battery charge LED indicator.

- For AC_PWR_DETECT to be active, requires the DC input voltage (from the AC power supply) exceed *10 volts.*

The AC_PWR_DETECT signal is also used to generate the signal BATTERY_SWX_ON* which controls a battery switch to turn ON using battery power when AC power and external DC power are removed.

- The other effect of BATTERY_SWX_ON* is delaying the battery charger from starting until the internal DC power supply reaches 10 volts.

A transient voltage suppressor protects the detection circuitry on the REG_DC_INTRNL.

External DC Power Conditioning / Detection Description

The external DC power input section limits current through a resettable fuse, both common and differential mode noise suppression and transient voltage protection. The *resettable fuse* limits current into the pump *from an external DC source.* Noise filtering is performed by input and output capacitors on the conditioning circuit together with a common mode choke.

The external power detector uses a *zener diode* to provide a valid logic high level when external DC power is applied. The active voltage for EXTRNL_PWR_DETECT is nominally *5 volts.* The threshold detector U3

provides immediate detection, through the signal BATTERY_SWX_ON*, of the external DC source being removed.

- A battery switch toggles to internal battery if both AC and external DC power are removed.
- The threshold detector also prevents the battery charger from charging the internal battery until the external DC power exceeds 5 volts.

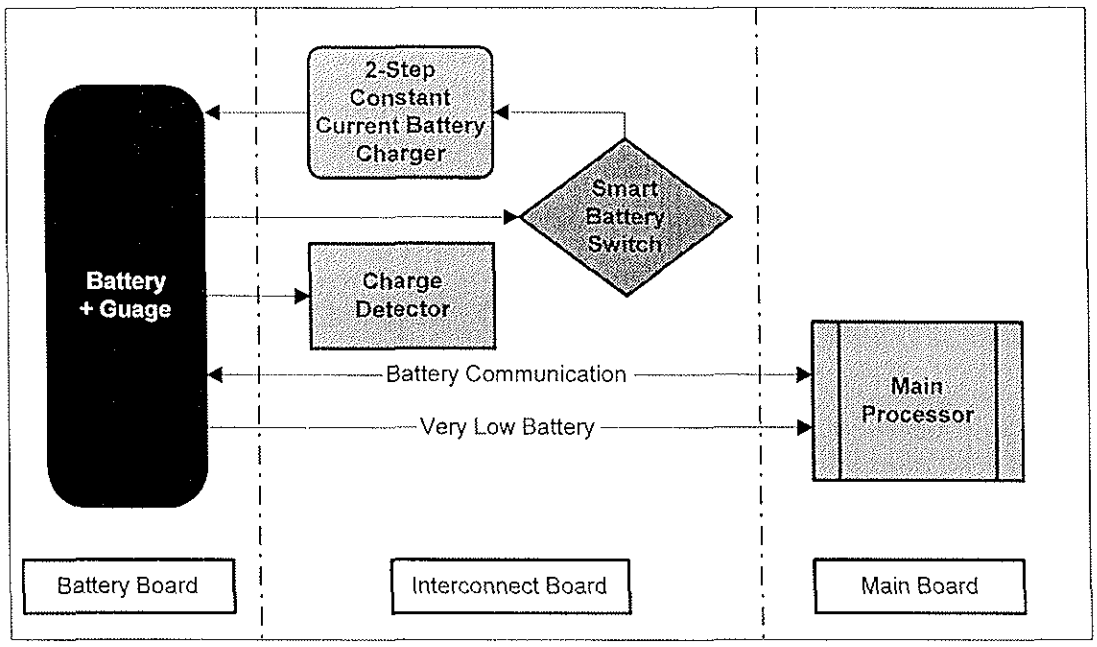
Infrared Serial Data Port Description

The *infrared serial port* interfaces directly with the main microprocessor's asynchronous serial communication pins. The infrared port supports short transmission distances of approximately *3" or less* and a maximum baud rate of 9600.

The Infrared Receiver signal from U1 is conditioned by the comparator circuit of U4 to generate a valid logic state to the microprocessor.
The Infrared Transmitter signal IR_XMT_DATA is at a logic high during its inactive state. A logic low on IR_$\overline{\text{XMT}}$_DATA enables the transmitting IR diode through the transistor Q3.

Battery Management Description

The battery management circuits are a 2-stage constant current battery charger, a charge detector, and a battery switch over control circuit. The interconnect board interfaces to a 6 cell NiCad battery pack with a "smart" battery gauge.



Flowchart of Battery Management Description

Battery Gauge Interface

The main microprocessor communicates to the battery through BATTERY_DATA – a single bi-directional serial data line.
A very low battery capacity status, VLOW_BATTERY*, signal protects the battery pack by disconnecting the battery. This signal is at a logic low when the battery is depleted.

Battery Charger

The battery charger allows charging a battery with an input supply voltage either above or below the battery voltage. Battery charging takes place when either the internal DC supply or external DC is present. The charger provides a charge current determined from three conditions:

- In normal operation the charge current is controlled by the gauge, providing two levels of constant charge current. If the battery capacity is less than 94% of its known capacity, the gauge will set CHARGE* to a logic low. This results in a charge current rate of C/6, approximately 270 *milliampere* giving a 6-8 hour recharge time.
- The gauge sets CHARGE* to logic high when the battery has been charged to 94% (or greater) of the battery's capacity, this lowers the charge rate to 65 *milliampere*, or C/25.
- A separate charge control circuit is the voltage limit for the battery; here a battery voltage monitoring circuit in the charger limits the charger to a voltage limit of 1.55 *volts per cell* (nominal). The charger keeps reducing the charge current in order to remain below this voltage limit. This prevents damage to the cells from excessive battery voltage.

Charge Detector

A charge detector circuit generates the control signal CHARGE_DETECT to control the illumination of a battery charge LED indicator and to reset the very low battery detector circuit located within the battery pack.

- The main microprocessor does not monitor the CHARGE_DETECT signal. However, the main microprocessor communicates with the gauge to determine charge status.

Battery Switchover

A *smart switch* selects a reliable source of power for the system power supplies. This switches to internal battery power when AC power and external DC power are removed from the pump (or when these sources are below acceptable thresholds detailed above).

- In normal operation, the *battery voltage* can be at a higher voltage than the external DC – especially during battery charging.

Battery Board – Schematic Level

The battery reports to the "Main" system microprocessor present status and controls battery charge from the Interconnect PCB . The battery PCB has

- a 3-volt Linear Regulator
- a Gauge IC
- and a Depleted Battery Monitor IC.

The local circuit allows the battery to maintain its current capacity regardless of where the battery resides.
The referenced schematic signal nets of the main board electronics are identified using names in SMALLCAPS.

Battery Gauge Function

The gauge IC, BQ2012, monitors direction and magnitude of current flowing through the battery.

- The current is sensed by the gauge as a voltage across R4.
- The gauge computes capacity.

To control charging the battery, the gauge uses battery temperature and battery voltage to update the battery capacity – which is a function of current and temperature.

The CHARGE* signal from the gauge controls the battery charger, located on the Main PC board, to charge at different rates depending on the state of the battery.

The gauge terminates standard charge in the event of the battery temperature exceeding 50°C or if the battery pack voltage is less than 5.7 volts.

Severely Depleted Battery Monitor

The depleted battery monitor IC senses the battery voltage to prevent an over-discharged battery. When the battery pack voltage reaches a nominal voltage of 5 volts, the IC sets the VLOW_BATTERY signal to a logic low, which disconnects all battery loads with the exception of the battery monitor circuit.

The battery charger provides the signal CHARGE_DETECT, which resets this monitor IC reconnecting the battery back to the system.

PART 3: TROUBLESHOOTING

Problem Solving Alarms / Alerts

This chapter defines basic problems and provides some standard problem solving procedures.

Types of Alarms / Alerts

The following table defines the alarms and alerts generated by the 3000 Series infusion pumps, with suggested remedies and solutions.

Type	Definition and Remedy
High Priority	A *high priority alarm* results from any condition which halts an ongoing infusion, or any pump system fault which affects infusion. High Priority alarms are signaled by a flashing red indicator and an audible signal. Press the **Alarm Silence** button to pause the audible alarm for the preset alarm silence period.
Medium Priority	A *medium priority* alarm indicates any condition requiring operator intervention but does not halt infusion. Medium Priority alarms are signaled with a flashing yellow indicator and an audible signal. Pressing the ALARM SILENCE button will silence the audible alarm for the programmed alarm silence period.
Low Priority	A *low priority* alarm indicates any condition not requiring immediate operator intervention. Low Priority alarms are signaled with a continuous yellow indicator and an intermittent audible signal. Pressing the ALARM SILENCE button permanently silences this alarm.
Limit	An *limit* alarm occurs whenever an invalid entry is attempted on a numerical entry screen. The invalid entry alarm sounds a brief tone with an advisory message onscreen.
"Neglected Pump"	The *"Neglected Pump"* alarm is a "medium" priority alarm. It is simply reminding you to finish what you started. Once you begin programming any infusion delivery setting, the pump expects you to continue until setup is complete. If you leave the pump paused too long (>30 seconds) on a data entry screen, then the pump sounds a medium priority alarm tone with the yellow indicator flashing.

Note: Neglected Pump and Limit alarms are not recorded in the pump's alarm history record.

Alarm Messages & Priorities

The following table defines alarm message, alarm priority, and cause for each alarm condition:

Alarm Message	Alarm Priority Programming	Alarm Priority Infusing	Cause or Corrective Action
BATTERY NOT CHARGING (SYSTEM ADVISORY)	Medium	Medium	Pump has sensed AC or DC external power is present, but the battery is not charging. Use Biomed *Diagnostics* and run MONITOR BATTERY STATUS to review battery function. Check battery connections and battery charge circuit on the interconnect board.
BATTERY NOT FUNCTIONAL (SYSTEM ADVISORY)	Low	Low	Pump has found no battery present – no charge current and no battery gage communication. Battery may be unplugged.
BATTERY COMMUNICATION TIMEOUT (SYSTEM ADVISORY)	Low	Low	Pump has sensed battery current present, but the battery gage on the battery pack is not communicating. Check connections from main board, to interconnect, to battery pack.
CHECK CLUTCH / PLUNGER LEVER	-	High	Normal alarm message. Software uses position potentiometer to monitor motion of the plunger driver during delivery. If the motion is not correct this alarm is generated. May be caused because pump was not primed and clutches took too long to engage, or may occur when user squeezes the plunger lever and moves plunger head. May also occur if position pot is not calibrated or is contaminated – use Biomed *Utilities* and run VIEW ALARM HISTORY to check if failure occurs at same position reading.
CHECK SYRINGE FLANGE SENSOR	High	-	At power-up, software has sensed the flange is loaded when no syringe is loaded in the pump (as sensed by the barrel clamp size sensor). Use Biomed *Diagnostics* and run MONITOR DIGITAL SENSORS to check function of flange sensor.
CHECK SYRINGE PLUNGER SENSOR	High	-	At power-up, software has sensed the plunger is loaded when no syringe is loaded in the pump (as sensed by the barrel clamp size sensor). Use Biomed *Diagnostics* and run MONITOR DIGITAL SENSORS to check function of both plunger sensors.
CLEAR TVD TO START INFUSION	Limit	-	Normal advisory message. Total volume delivered (TVD) or total dose delivered (TDD) needs to be cleared to start an infusion when TVD/TDD exceeds the volume limit setting.
COMPLETING SYSTEM INITIALIZATION	Limit	-	Normal advisory message. At power-up, if all settings are entered by the user and START pressed before background self-tests are completed, then this message appears. Wait a few seconds until self-testing is completed and then press START to begin infusion.

DEPLETED BATTERY	High	High	Normal alarm message. Battery voltage measured by the gage on the battery pack is too low. Software then stops delivery and allows watchdog to generate alarm. Plug pump into AC power, cycle power on the pump, then use RECALL LAST SETTINGS to recall delivery settings and resume delivery. If problem is chronic, check battery pack function or perform battery calibration.
INFUSION COMPLETE	-	High	Normal alarm message. Infusion has reached the set volume limit and delivery has stopped.
INPUT OUT OF RANGE	Limit	-	Normal advisory message. User attempted to enter number outside the range of available settings. (See also "maximum rate" in general problems below).
INVALID SYRINGE SIZE	High	High	Syringe size (barrel clamp potentiometer sensor) does not match selected manufacturer or when barrel clamp is lifted during delivery, this alarm occurs. If there is any question about this sensor's function perform PM check of barrel clamp calibration.
INVALID RATE FOR SYRINGE SIZE	High	-	Normal advisory message. When using E-plates library entries, the library stores syringe size. Changing this size may cause this message to appear (refer to appendix of Operation Manual for syringe size/rate tables).
KVO IN PROGRESS	-	Medium	Normal alarm message. Infusion has reached the set volume limit and delivery changed to KVO rate.
LOW BATTERY	Low	Low	Normal advisory message. Battery gage has measured the capacity of the battery is less than 10%. The infusion rate will determine the run time remaining on the battery.
OCCLUSION	-	High	Normal alarm message. The force sensor in the plunger driver has sensed occlusion of the infusion line when the force value exceeds the set limit. If this is a chronic problem review: (a) the configured occlusion limit – the setting appears on graph on delivery screen as VL, L, N, H – use Configuration Manual to change settings; or (b) the infusion setup high rates through micro-bore tubing can give high back-pressures.
PUMP IS LOCKED	-	Limit	Normal advisory message. Press the UNLOCK menu key before changing settings during delivery.
SYRINGE DOES NOT MATCH LIBRARY ENTRY	Limit	-	Normal advisory message. When using E-plates library entries, the library stores syringe size. Here, this is advisory message that syringe does not match the library entry.
SYRINGE EMPTY	-	High	Normal alarm message. The plunger driver position potentiometer has sensed that the syringe is empty. This position (in a software table) is different for each syringe manufacturer and syringe size.
SYRINGE EMPTY - MANUAL	-	High	Normal alarm message. After reaching "SYRINGE EMPTY" position, the user can press START to resume infusion – in cases where there is a small amount of fluid left in the syringe. Here, the pump delivers until the force sensed on the plunger driver reaches the set occlusion limit – as the plunger pushes against the end of the syringe barrel.

SYRINGE NEAR EMPTY	-	Medium	Normal advisory message. Notice that only a few minutes of fluid remain in the syringe. This alarm is configurable for the number of minutes notice or may be turned off entirely.
SYRINGE FLANGE NOT IN PLACE	High	High	Pump has sensed the flange is not loaded when syringe is loaded in the pump (as sensed by the barrel clamp size sensor). User may not have loaded syringe correctly. If necessary, use Biomed *Diagnostics* and run MONITOR DIGITAL SENSORS to check function of flange sensor.
SYRINGE PLUNGER NOT IN PLACE	High	High	Pump has sensed the plunger is not loaded when syringe is loaded in the pump (as sensed by the barrel clamp size sensor). User may not have loaded syringe correctly. If necessary, use Biomed *Diagnostics* and run MONITOR DIGITAL SENSORS to check function of both plunger sensors.
SYSTEM ADVISORY – "description"	Low	-	See detailed descriptions in section below.
SYSTEM FAILURE – "description"	High	High	See detailed descriptions in section below.
"user call-back" (no message)	Medium	Medium	If pump is left in a user input screen (e.g. set rate or titrate rate) for more than 30 seconds the pump alarms. *Go to* pause screen or main screen to get longer alarm silence intervals.

System Advisory Alarms

This section explains the system advisory alarms in the 3000 Series infusion pump, and suggests possible causes and remedies for these alarms.

System Advisory Alarm	Cause or Remedy
BACKUP CRITICAL DATA CORRUPTED	Configuration and library settings are stored redundantly in non-volatile serial EEROM on the main board. This message will occur if backup data was lost, and primary data was used to restore backup values. No action is required.
DEFAULT CONFIGURATION RESTORED	Configuration settings are stored redundantly in non-volatile serial EEROM on the main board. If both primary and backup are lost, the configuration is defaulted. Use pump Custom Program TEACH/LEARN to copy configuration from a known good pump to restore settings. If problem persists, there may be a problem with the main board. This message may appear when a new main board is installed.
HISTORY DATA CORRUPTED	Infusion history log is stored in non-volatile serial EEROM on the main board. This message will occur if this data is lost. No action is required.
NON CRITICAL DATA CORRUPTED	Other settings are stored in non-volatile serial EEROM on the main board. This message will occur if this data was lost. No action is required.
PRIMARY CRITICAL DATA CORRUPTED	Configuration and library settings are stored redundantly in non-volatile serial EEROM on the main board. This message will occur if primary data was lost, and backup data was used to restore primary values. No action is required.
SET TIME AND DATE	Advisory message that real time clock has reset on the pump. This may occur if the battery is depleted and the main board supply totally discharged – the super-capacitor on main board should keep up the clock for many days after a depleted battery is reached. Use Biomed *Utilities* and run SET TIME/DATE to restore date and time settings. No functionality of pump is affected by date/time setting.

System Failure Alarms

This section discusses the diagnosis of system failure alarms in the 3000 Series infusion pump, and suggests possible causes and remedies for these alarms.

System Failure Alarm	Cause or Remedy
A2D REFERENCE VOLTAGE BGND TEST	Background self-test measured an invalid range on analog-to-digital converter reference voltage. Use Biomed *Diagnostics* to check the voltage. Replace the main board if invalid voltage found.
ACU POWER STROBE FAILURE	Self-test has found that the ACU processor is not maintaining its power strobe. If this failure repeats, then try full reset of main board – disconnect AC power, open pump, disconnect battery, short super-cap through ~100 ohm load; then reassemble pump and retest. Replace main board if problem persists.
ACU WATCHDOG FAILURE	Self-test has found that the ACU watchdog alarm signal active. This alarm may occur if processor failed to pet watchdog within allotted time (e.g. a software failure occurred). If problem recurs, replace the main board.
ANALOG SUPPLY VOLTAGE BGND TEST	Background self-test measured an invalid range on analog supply voltage. Use Biomed *Diagnostics* to check the voltage. Replace the main board if invalid voltage found.
AUX CONTROLLER UNIT POST	Power-up self-test has found that the ACU processor failed to shut down motor current during the watchdog alarm test. If problem recurs, replace the main board.
BACKGROUND CRC TEST TIMEOUT	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
BACKGROUND SELF TEST TIMEOUT	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
BACKUP AUDIBLE ALARM POST	Power-up self-testing has found that the backup audible alarm (controlled by ACU) is not working at correct power (current) or frequency. Replace the alarm buzzer on the main board or replace the main board.
CALIBRATION REQUIRED	Calibration values stored in non-volatile serial EEROM memory are invalid. This message appears whenever a new main board is installed. Calibrate all the sensors in the pump.
CONTROL KEY SWITCH BGND TEST	Key on keypad was found stuck on during continuous background self-test. Use Biomed *Diagnostics* to determine which key is stuck. If stuck key is found, replace keypad.
CONTROL KEY SWITCH POST	Key on keypad was found stuck on during power-on self-test. Use Biomed *Diagnostics* to determine which key is stuck. If stuck key is found, replace keypad.
CRITICAL DATA BLOCK BGND TEST	Delivery settings are stored in a critical data block of RAM on the main board. This message will occur if background self-test showed the critical data block was corrupted (i.e. a RAM cyclic redundancy test failed). Run power-on self test which executes extensive RAM testing – if problem recurs, replace the main board.
CRITICAL DATA BLOCK POST	Configuration and library settings are stored redundantly in non-volatile serial EEROM on the main board. This message will occur if backup data and primary data are both good, but fail to agree. Use pump Custom Program TEACH/LEARN to copy configuration from a known good pump to restore settings. Replace main board if serial EEROM has failed.

CRITICAL DATA FAILURE	After settings are programmed into the pump, the pump performs a reverse calculation to insure all settings are correct. Using incompatible ranges of settings may cause this alarm (e.g. using concentration of 1000 mg/ml and trying to set a rate of 0.1 microgram/hour). Review pump settings. Alternatively, this alarm may indicate a software data failure where critical flags are found invalid. If problem recurs, replace the main board.
D2A OFFSET VOLTAGE BGND TEST	Background self-test found failure in force sensor offset signal. Probably a failure in the main board digital-to-analog converter or a failure in the plunger cable/board. Use Biomed *Diagnostics* to check force sensor voltage readings.
DEPLETED BATTERY	Battery is fully discharged below low voltage threshold. Plug in the pump to AC power or external DC power to recharge the battery.
DISPLAY CONTROLLER POST	Failure detected in testing the LCD display. Check cabling between main board and display. Replace LCD display.
EXTERNAL COM TASK TIMEOUT	External computer or device connected to the pump is sending too many commands too quickly, or sending too many invalid commands and this causes the software to timeout. Remove the 3000 series external RS232 adapter and observe if the problem is corrected.
FLASH MEMORY BGND TEST	CRC failure found in program memory during background self-tests. Failure may occur during external re-programming of the pump software. Otherwise failure is in flash memory of the main board, and main board should be replaced.
FLASH MEMORY POST	CRC failure found in program memory during power-up self-tests. Failure may occur during external re-programming of the pump software. Otherwise failure is in flash memory of the main board, and main board should be replaced.
FORCE SENSOR BGND TEST	Background self-test has found the force sensor signal out-of-range or the force sensor signal did not change when bridge-test signal was asserted. Use Biomed *Diagnostics* MONITOR ANALOG SENSORS to check operation of plunger force sensor. Open plunger head and check plunger cable and force sensor cable on the plunger board. Replace plunger board, plunger cable or force sensor.
FORCE SENSOR BRIDGE TEST	Software sensed no voltage change when sensor test signal was asserted. The force sensor bridge (strain gage) may be unplugged or have an open connection. Use Biomed *Diagnostics* MONITOR ANALOG SENSORS to check operation of plunger force sensor. Open plunger head and check plunger cable and force sensor cable on the plunger board. Replace plunger board, plunger cable, or force sensor.
FORCE SENSOR TEST	Power-up self test found that the force sensor output did not change when the DAC offset voltage was changed. May be problem on main board offset circuit, plunger board, plunger cable, or force sensor. Check cabling first.
INPUT TASK TIMEOUT	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
INTERNAL A2D FAILURE	Software self-test identified a failure in the 10-bit analog to digital converter. Use Biomed *Diagnostics* , check analog sensor readings. If they are abnormal, replace the main board.
INVALID INTERRUPT	Software/hardware failure. Software attempted to execute invalid interrupt, may be caused by main processor hardware failure, bus failure, or software flash memory failure.
LED TASK TIMEOUT	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
LOGIC SUPPLY VOLTAGE BGND TEST	Background self-test measured an invalid range on logic supply voltage. Use Biomed *Diagnostics* to check the voltage. Replace the main board if invalid voltage found.

MCU POWER STROBE FAILURE	Failure in self-test of power strobe (output port) signal from the main processor. Replace the main board if problem recurs.
MONITOR TASK TIMEOUT	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
MOTOR FAILED TO STOP ERROR	Software sensed motor rotation after stop pump motor was executed. This could be caused by failing motor rotation (photo-reflective) sensor on the back of the main board. Use Biomed *Diagnostics* to run motor drive test (set motor step period to ~100 msec) then use monitor digital sensors to check motor rate sensor. Stop motor and rate sensor should stop changing. Replace the main board if sensor has failed.
MOTOR NOT RUNNING ERROR	Motor sensor did not detect any rotation of the stepper motor. Sensor (on main board) may have failed, or worm/gear/leadscrew may be jammed.
MOTOR RATE ERROR	Motor sensor did not measure the correct rotation rate for the stepper motor. Sensor (on main board) may have failed, or the force sensor may be inoperative and the stepper motor stalled when an occlusion occurred.
MOTOR SUPPLY VOLTAGE BGND TEST	Background self-test measured an invalid range on motor supply voltage. Use Biomed *Diagnostics* to check the voltage. Replace the main board if invalid voltage found
PLUNGER SENSOR FAILURE	Software sensed plunger sensor voltage out of range. The plunger position sensor (potentiometer) may be unplugged or have an open connection. Use Biomed *Diagnostics*, monitor analog sensors to check operation of plunger position sensor. Open pump case and check connections to plunger sensor. Replace plunger position sensor.
PRIMARY AUDIBLE ALARM BGND TEST	Background self-test sensed no current flowing in the primary speaker. Speaker may be unplugged or wire came loose from connector. Check connections from main board to interconnect and from interconnect board to speaker. Replace speaker if wiring is intact.
PRIMARY AUDIBLE ALARM POST	Power-up self-test sensed no current flowing in the primary speaker. Speaker may be unplugged or wire came loose from connector. Check connections from main board to interconnect and from interconnect board to speaker. Replace speaker if wiring is intact.
PUMP MOTOR DRIVE OFF POST	Power-up self-test sensed no current in the stepper motor. Motor supply or motor driver circuit may have failed. Verify motor connections are correct, then use Biomed *Diagnostics*, motor drive test to check motor operation. If motor does not run replace the motor or the main board.
PUMP MOTOR DRIVE PHASE A POST	Power-up self-test found the stepper motor winding open. Motor may be unplugged or wire came loose from winding. Replace motor if wiring is intact.
PUMP MOTOR DRIVE PHASE B POST	Power-up self-test found the stepper motor winding open. Motor may be unplugged or wire came loose from winding. Replace motor if wiring is intact.
RAM BGND TEST	Software test showed failure of a RAM on the main board. Cycle power and run rerun power-up self test which executes more extensive RAM test. If failure recurs, then check the main board to insure no cable or contamination is shorting the board, then replace the main board.
SERIAL EEPROM TIMEOUT	Software test showed failure of a serial EEROM on the main board. Check the main board to insure no cable or contamination is shorting the board, then replace the main board.
SPI BUS TIMEOUT	Software test showed failure of some component on the SPI bus. Check the main board to insure no cable or contamination is shorting the board, then replace the main board.

SUPERCAP POST	Power-up self-test sensed insufficient charge in the super-capacitor. This problem can occur with a new main board or when a pump battery is totally dead. Plug pump into AC power for at least two minutes then cycle power. If problem is not corrected, then replace the main board.
SYRINGE SENSOR FAILURE	Software sensed syringe sensor voltage out of range. The sensor (potentiometer) may be unplugged or have an open connection. Use Biomed *Diagnostics*, monitor analog sensors to check operation of syringe sensor. Open pump case and check connections to syringe sensor. Replace syringe sensor.
TIME BASE BGND TEST	Background self-test found the system (MCU) time base did not agree with the time of day clock tick. Problem with oscillator for MCO or oscillatory for real time clock. If problem recurs, replace main board.
TIME OF DAY CLOCK POST	Power-up self-test found the system (MCU) time base did not agree with the time of day clock tick. Problem with oscillator for MCO or oscillatory for real time clock. If problem recurs, replace main board.
TIME OF DAY CLOCK TIMEOUT	Time of day clock failed to communicate. If problem recurs, replace main board.

General Troubleshooting

This section discusses some potential problems which may be encountered with the 3000 Series infusion pump, and suggests remedies for those problems.

Problem	Remedy or Solution
Alarms Do Not Sound (Either Loudly or At All)	a) If the alarms sound faintly, they may have been configured to their lowest level. Use CUSTOM PROGRAM to change the audio alarm volume to a higher level. b) Use Biomed *Diagnostics* and run the AUDIO TEST on Speaker and Alarm Style. Replace speaker if audio alarm does not work correctly.
Battery Problem: No charge light	a) Connect to AC power. Turn on pump and allow to complete startup self-testing. If both AC indicator and charge lights are off then see "Indicators Do Not Flash" below. b) Use Biomed *Diagnostics* and run the MONITOR BATTERY STATUS test. Determine whether battery is charging at 50 MA or greater.
Battery Problem: Battery not working message	a) Open the battery door in the case bottom and check the connection of the battery ribbon cable to the interconnect board. b) Otherwise, use Biomed *Diagnostics* and run the MONITOR BATTERY STATUS test. If no information appears then replace the battery pack.
Battery Problem: Battery does not hold charge	a) Open the battery door in the case bottom and check the connection of the battery ribbon cable to the interconnect board. b) **Connect to AC power.** Turn on pump and allow to complete startup self-testing. Use Biomed *Diagnostics* and run the MONITOR BATTERY STATUS test. Check whether battery is charging at least +50 MA (wait at least 1 minute from power-on for charge current reading to stabilize). • Unplug AC power if pump immediately shuts down then replace battery pack. • If pump continues to operate and gauge shows normal discharge current -100 to -200 ma, then perform a battery calibration.
Indicators (Lights) Do Not Flash	If the indicator lights do not flash during startup, or along with their appropriate function or alarm, then: a) Open the case and check the keypad connection to the Main Board. If any connections are loose, reconnect and re-test. b) Otherwise, replace keypad.
Keyclick (Beep) is Faint or Not Present	If the keyclicks (beeps) sound faintly, or not at all, they may have been configured to their lowest level or turned OFF. Use CUSTOM PROGRAM to reset the audio to a higher level.
Keypad Button Does Not Work	Use Biomed *Diagnostics* and run the KEYPAD TEST. If any keys do not pass this test, open the case and check connections for the keypad.
Liquid Crystal Display has poor contrast.	Use Biomed *Calibration* and run the ADJUST CONTRAST. If the LCD contrast cannot be adjusted, then check LCD negative supply, and consider replacing display or main board..
Libraries Not Available	Libraries may have been turned off or cleared in pump configuration. Use CUSTOM PROGRAM, *Teach mode* or *Learn mode* to copy the Libraries from a correctly configured pump. See Configuration Manual.

Maximum Rate Not Available	Maximum rate may be set low in pump configuration. Use CUSTOM PROGRAM, *Set max flow rate* to configure the pump's maximum flow rate. See Configuration Manual.
Occlusion Alarms Frequently Occur	Occlusion alarm limit may be set too low in pump configuration. Use CUSTOM PROGRAM, *Set occlusion limit* to configure the pump's occlusion alarm level. See Configuration Manual.
Pump Won't Turn On	Plug into AC power (pump will not turn on with a dead battery) then push and hold power key to turn on. Otherwise, open case and check: a) Connections of main to interconnect ribbon cable b) AC power connections. c) Battery connections. d) Keypad cable connections.
Syringe Manufacturer Not Available	Syringe manufacturer may have been turned off or cleared in pump configuration. See Configuration Manual.

Medex Service and Support

Using Medex Service Assistance

Use the following steps to make use of Medex technical service assistance:

1. Contact Medex Technical Service Department at one of the following telephone numbers:

Toll free in continental United States 800-848-1757	Outside Continental United States 614-889-2220
Contact via Fax in United States 770-497-0736	In Europe contact Medex Medical Ltd., UK 44-1706-233814

2. When calling any of these numbers, please have the following ready:
   - *Model name / number of pump*
   - *Pump serial number*
   - *Purchase date if pump is within warranty period*
   - *Description of problem in as much detail as possible*
3. The technical service representative will "talk you through" to a solution if possible.

Returning a 3000 Series Pump for Repair

When the service representative cannot solve your problem by phone, then it becomes necessary to return the 3000 Series infusion pump for service.

1. If the problem cannot be resolved through the assistance of the Technical Service Department, then you will be assigned a Return Authorization (RA) number.
2. Clean and decontaminate the pump and accessories prior to returning items to **Medex**. This is required before shipment by United States Occupational Safety & Health Administration (OSHA).
3. Package the infusion pump carefully for shipment.
4. ***Medex will not accept returns for service without the assigned RA number clearly printed on the shipping package.*** Mark the Return Authorization (RA) number clearly on the outside of the shipping package used to return the pump.
5. The shipment method must meet the environmental conditions of:

	Shipping:	**Storage:**
Temperature:	*-40° to 60° C (-40° to 140° F)*	*-20° to 50° C (-4° to 122° F)*
Relative Humidity:	*5 to 95% non-condensing*	*5 to 95% non-condensing*
Atmospheric Pressure:	*50 to 108 kPa (7.3 to 15.4 psia)*	*50 to 108 kPa (7.3 to 15.4 psia)*

6. Ship the carefully packaged 3000 Series infusion pump to either of the addresses listed below:

Medex **4350 River Green Parkway, Suite 200** **Duluth, Georgia 30096** **USA** **800-848-1757**	**Medex Medical Ltd.** **ISTD Department** **Haslingden, Rossendale, Lancs** **BB4 4PW United Kingdom** **+44-1706-233814**

Using Biomed Program for Troubleshooting

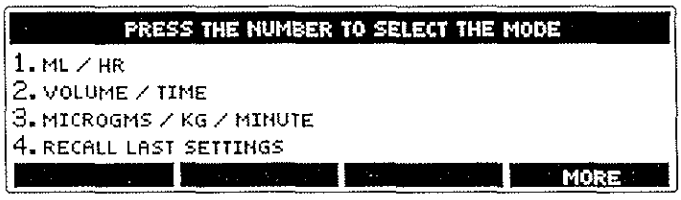
The primary tools for troubleshooting the 3000 Series infusion pump are available through the Biomed Program which contains DIAGNOSTICS, CALIBRATION, UTILITIES, & UPDATE FIRMWARE features. This is a part of the basic software installed in all 3000 series pumps. The 3500 pump additionally has the ability to change the displayed language.

Two features within UTILITIES are very useful for investigating user complaints on the pump: VIEW INFUSION HISTORY and VIEW ALARM HISTORY. View infusion history allows review of infusion pump settings, delivery information, and alarms with each entry date and time stamped. View alarm history allows review of pump alarms (together with sensor data) with each entry date and time stamped.

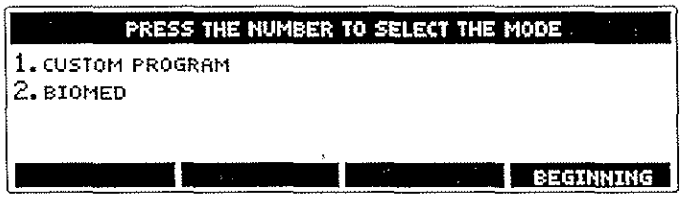
There are many features under DIAGNOSTICS which allow the examination of various sensors and components within the pump. The speaker, motor, keypad, indicators and display may be tested individually through this program. The battery gauge status information and charging/discharging current may be viewed. Numerous digital and analog inputs may also be viewed.

Starting Biomed Software Program

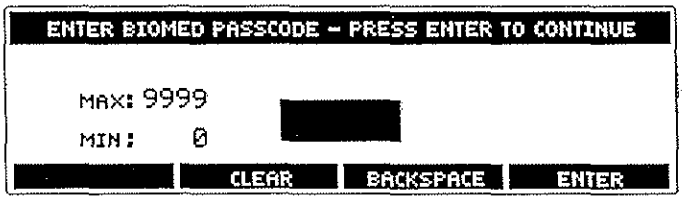
1. Turn on pump and allow the power-on, self-testing to complete. If there is a system failure detected in power-on testing, then the pump will directly go to ENTER BIOMED PASSCODE screen.



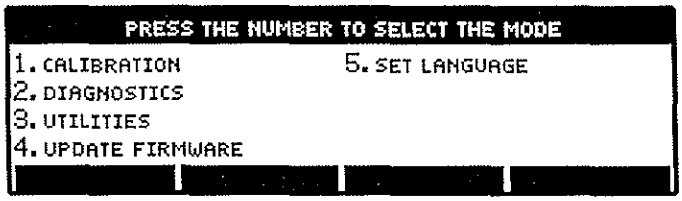
2. Press the **More** button until the BIOMED option appears onscreen. (If E-Plates are *enabled*, you will have to press the **Main** Menu button before using **More** to locate BIOMED.)



3. Press the number button to select BIOMED option



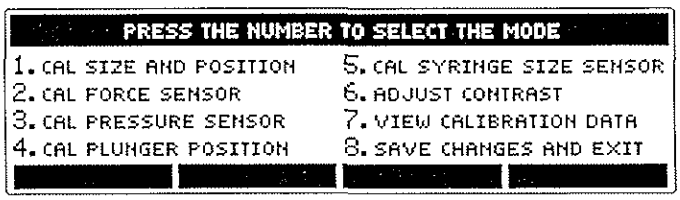
4. Key in the Biomed Pass code, 2580, and press the **Enter** button.



5. Now you may select:
   - CALIBRATION to check calibration values, re-calibrate sensors or set display contrast.
   - DIAGNOSTICS to examine analog and digital signal readings, or test the speaker, motor or display function.
   - UTILITIES to review alarm history, to review infusion history, to set time and date, to update periodic maintenance timestamp.
   - UPDATE FIRMWARE to reprogram the pump's software version through the serial interface (only available with service upgrade software diskette and instructions).
   - SET LANGUAGE to change the national language displayed. [Available on 3500 pumps.]

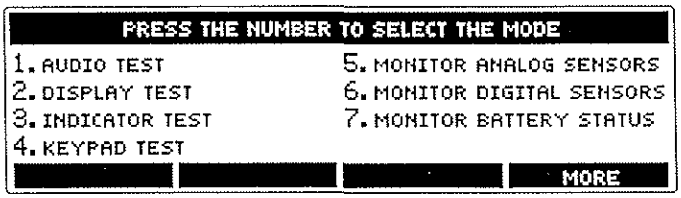
Biomed CALIBRATION

Within Biomed Calibration the following selections are available. See the Calibration part of this manual for further details.


PRESS THE NUMBER TO SELECT THE MODE
1. CAL SIZE AND POSITION
2. CAL FORCE SENSOR
3. CAL PRESSURE SENSOR
4. CAL PLUNGER POSITION
5. CAL SYRINGE SIZE SENSOR
6. ADJUST CONTRAST
7. VIEW CALIBRATION DATA
8. SAVE CHANGES AND EXIT

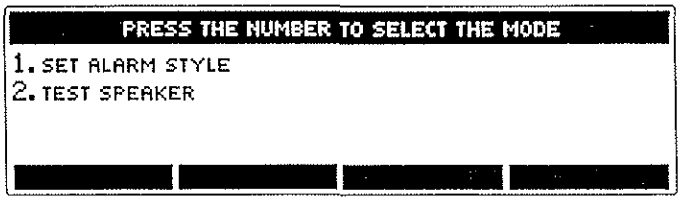
Biomed DIAGNOSTICS (screen 1 of 2)

Within Biomed Diagnostics the following selections are available (one of two screens). Use the number buttons to select the test.



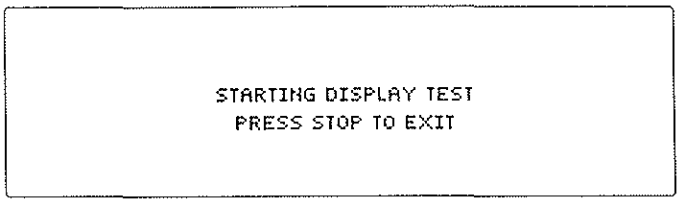
Audio Test

Use the number keys to select the test. SET ALARM STYLE allows testing of the various alarm tones. TEST SPEAKER is a factory/engineering test.



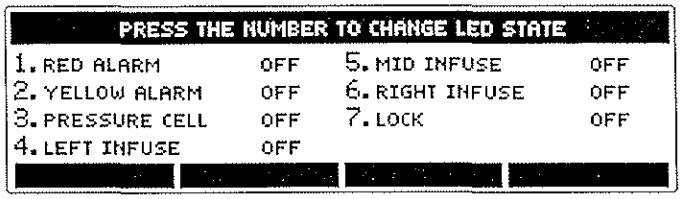
Display Test

Display test repeats blank, all pixels on, vertical lines, horizontal lines, and checkerboard patterns across the LCD display. This test may only be exited by use of the **Stop** button.



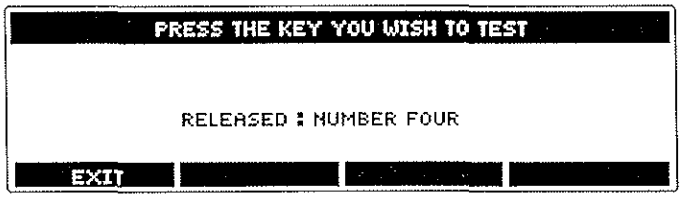
Indicator Test

The indicator test allows the individual control and testing of each indicator on the front panel (except battery and AC). Press the number button for the indicator to toggle on or off.


PRESS THE NUMBER TO CHANGE LED STATE
1. RED ALARM OFF
2. YELLOW ALARM OFF
3. PRESSURE CELL OFF
4. LEFT INFUSE OFF
5. MID INFUSE OFF
6. RIGHT INFUSE OFF
7. LOCK OFF

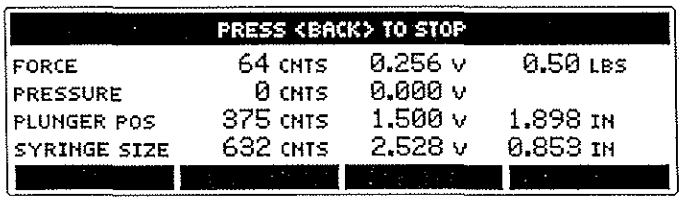
Keypad Test

The keypad test allows each key to be tested. The only exit from this test is the **Exit** menu button.



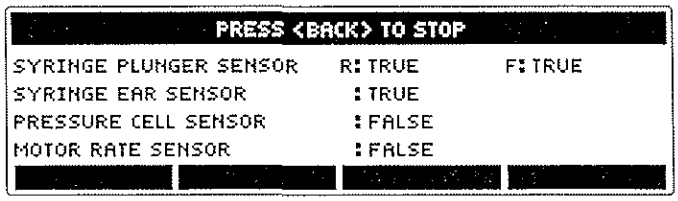
Monitor Analog Sensors

The monitor analog sensors allows viewing the high resolution analog signals in the pump. These are force, pressure (future option), plunger position, and syringe size. The first data column is analog to digital converter counts (0 to 1023), the second column is the voltage equivalent to counts, and the third column is the reading with calibration values applied.


PRESS <BACK> TO STOP
FORCE 64 CNTS 0.256 V 0.50 LBS
PRESSURE 0 CNTS 0.000 V
PLUNGER POS 375 CNTS 1.500 V 1.898 IN
SYRINGE SIZE 632 CNTS 2.528 V 0.853 IN

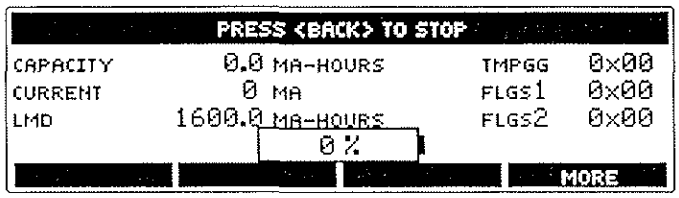
Monitor Digital Sensors

Monitor digital sensors allows viewing the state of the digital sensors in the pump. Syringe plunger sensor is the state of the flippers on the plunger head where open is true. Syringe ear (flange) sensor indicates true when the ear clip (flange) is pulled out. Pressure cell is future option. The motor rate sensor with show true or false depending upon the position of the reflective surface on the end of the motor/worm shaft.


PRESS <BACK> TO STOP
SYRINGE PLUNGER SENSOR R: TRUE F: TRUE
SYRINGE EAR SENSOR : TRUE
PRESSURE CELL SENSOR : FALSE
MOTOR RATE SENSOR : FALSE

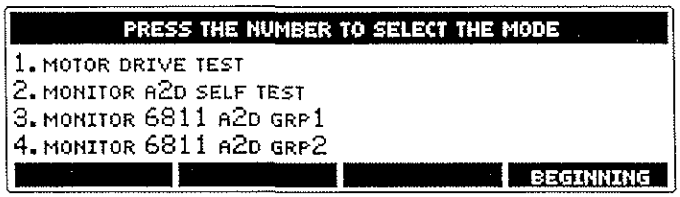
Monitor Battery Status

Monitor battery status shows the information from the battery gage. It may take up to 1 minute for current readings to stabilize when changing from charge to discharge or visa versa. If current is positive the battery is charging; thus negative is discharging. See schedule maintenance for discussion of battery gage.



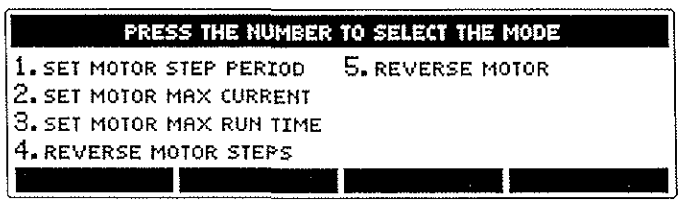
Biomed Diagnostics (screen 2 of 2)

Within Biomed Diagnostics the following selections are available (one of two screens). Use the number buttons to select the test.


PRESS THE NUMBER TO SELECT THE MODE
1. MOTOR DRIVE TEST
2. MONITOR A2D SELF TEST
3. MONITOR 6811 A2D GRP1
4. MONITOR 6811 A2D GRP2
BEGINNING

Motor Drive Test

This test allows running the motor without any alarms (position, rotation, etc.) being active. Only use the SET MOTOR STEP PERIOD feature. Enter a motor step period where 2 millisec is the fastest rate and 1000 millisec is the slowest rate, then press the **start** button to start the motor and the **stop** button to stop. All other features are for factory/engineering use.

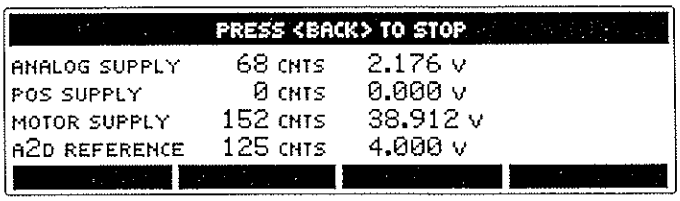

PRESS THE NUMBER TO SELECT THE MODE
1. SET MOTOR STEP PERIOD
2. SET MOTOR MAX CURRENT
3. SET MOTOR MAX RUN TIME
4. REVERSE MOTOR STEPS
5. REVERSE MOTOR

Monitor A2D Selftest

These are self-test values within the high-resolution analog to digital converter. This feature is for factory/engineering use. The normal readings are full scale equals 1023, midrange equals 512, and zero equals 0.

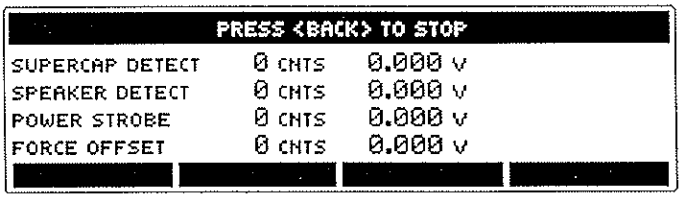
Monitor 6811 A2D Group1

This monitor analog sensors allows viewing the low resolution analog signals in the pump. These are analog supply, positive supply, motor supply, and a2d reference. The first data column is analog to digital converter counts (0 to 255), the second column is the "normalized" voltage equivalent to counts multiplied by the resistor divider feeding that channel. See Main Board theory of operation for definition of signals and values.


PRESS <BACK> TO STOP
ANALOG SUPPLY 68 CNTS 2.176 V
POS SUPPLY 0 CNTS 0.000 V
MOTOR SUPPLY 152 CNTS 38.912 V
A2D REFERENCE 125 CNTS 4.000 V

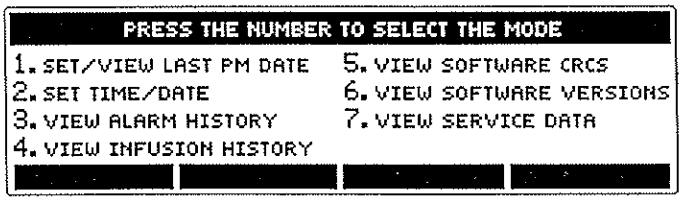
Monitor 6811 A2D Group2

This monitor analog sensors allows viewing the low resolution analog signals in the pump. These are supercap detect, speaker detect, power strobe, and force offset. The first data column is analog to digital converter counts (0 to 255), the second column is the "normalized" voltage equivalent to counts multiplied by the resistor divider feeding that channel. See Main Board theory of operation for definition of signals and values.


PRESS <BACK> TO STOP
SUPERCAP DETECT 0 CNTS 0.000 V
SPEAKER DETECT 0 CNTS 0.000 V
POWER STROBE 0 CNTS 0.000 V
FORCE OFFSET 0 CNTS 0.000 V

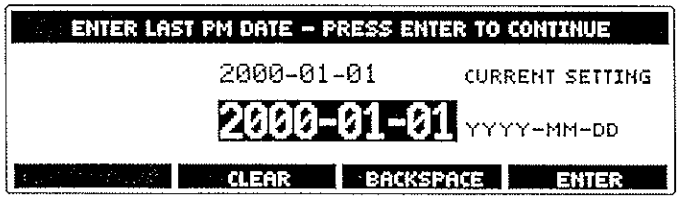
Biomed Utilities

Within Biomed Utilities the following selections are available. Use the number buttons for selection.


PRESS THE NUMBER TO SELECT THE MODE
1. SET/VIEW LAST PM DATE
2. SET TIME/DATE
3. VIEW ALARM HISTORY
4. VIEW INFUSION HISTORY
5. VIEW SOFTWARE CRCS
6. VIEW SOFTWARE VERSIONS
7. VIEW SERVICE DATA

Set/View Last PM (Periodic Maintenance) Date

This feature should be used every time that periodic maintenance is performed on the pump. Use the number keys to enter the current date of maintenance into the pump, then this value is stored in non-volatile memory. When two years elapse from this date, an advisory message (low priority alarm) appears on the power-up screen for annual maintenance to be performed. [Note: ensure current date and time are correct in SET TIME/DATE.]

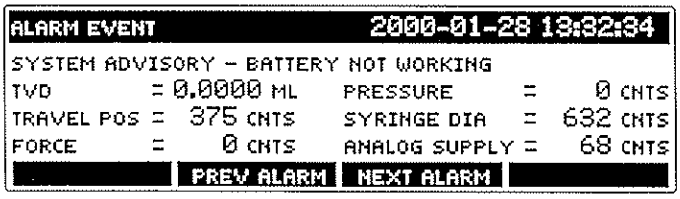


Set (Current) Time/Date

This feature allows setting the current date and time. This setting is stored in a clock/calendar chip on the main board. [Note: if all power is removed from the main board and the super-capacitor is drained, the clock will be reset to 1998 and PM advisory message may appear until clock is set.]

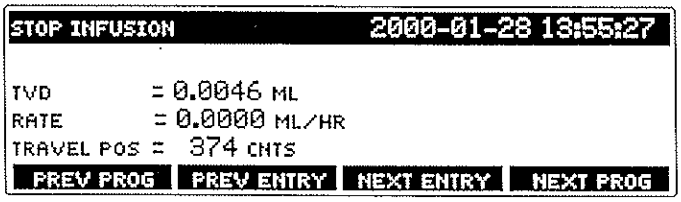
View Alarm History

This feature allows review from the most recent alarm backwards in time. Each alarm is date and time stamped. [Note: see latest power-on record in view infusion history to check current clock/calendar settings.]


ALARM EVENT 2000-01-28 13:32:34
SYSTEM ADVISORY - BATTERY NOT WORKING
TVD = 0.0000 ML
PRESSURE = 0 CNTS
TRAVEL POS = 375 CNTS
SYRINGE DIA = 632 CNTS
FORCE = 0 CNTS
ANALOG SUPPLY = 68 CNTS
PREV ALARM
NEXT ALARM

View Infusion History

This feature allows the review of infusion history from the most recent time backwards. Each entry is date and time stamped. The infusion history is "event" driven with entries made for start infusion, stop infusion, change rate, alarms, etc. Depending upon complexity of infusions, the infusion history stores approximately 8 or more complete infusions. Use **prev entry** button to step backwards one event at a time, or use **prev prog** button to step back one infusion at a time. Here, **next entry** and **next prog** step forwards in time one event or one infusion respectively.

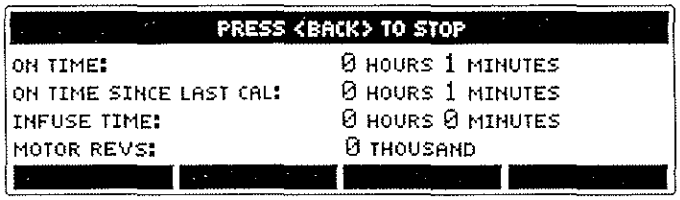


View Software CRCs & View Software Versions

Theses features are for factory/engineering use.

View Service Data

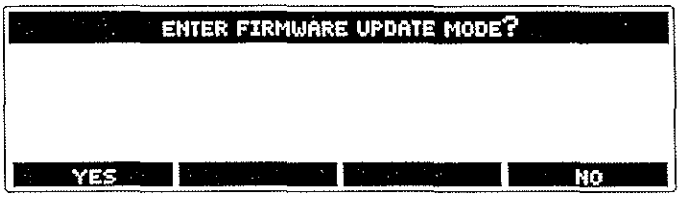
This feature is for factory service allows the service department to review the data on pump usage.


PRESS <BACK> TO STOP
ON TIME: 0 HOURS 1 MINUTES
ON TIME SINCE LAST CAL: 0 HOURS 1 MINUTES
INFUSE TIME: 0 HOURS 0 MINUTES
MOTOR REVS: 0 THOUSAND

Biomed Update Firmware

Do Not Use this feature unless specifically authorized by Medex to update the software of the pump. Review the documentation provided with the software update. Follow the instructions provided with the software update and insure the update is compatible with the pump model before performing a software update.

[Note: pressing the **Yes** menu button does not erase any software in the pump. The pump must be connected to a host personal computer running a 3000 Series download program and a download must be initiated on the PC in order to update the pump's software.]

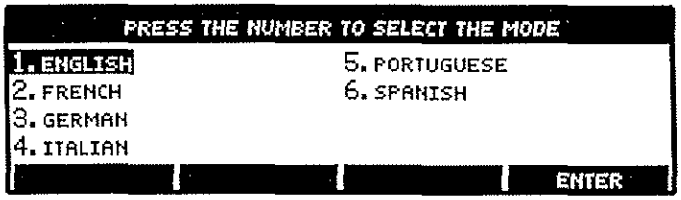


Set Language (Not available on 3010 and 3010a)

Selecting this option permits changing the displayed language on the pump. All messages will be displayed using the new language.

To select a language, press the number corresponding to the language, and press **enter**. The display will immediately change to the selected language. Some pumps may not have all languages implemented; selecting an unimplemented language will result in English being selected.

Note: Do not select a language unless you know how to read and understand that language.



PART 4: PARTS REPLACEMENT

This part of the manual provides procedures for disassembly, parts replacement & re-assembly of the pump.

Maintenance Warnings/Cautions

Observe the following warnings and cautions while disassembling, replacing parts, and reassembling any 3000 Series infusion pump.

After reassembling pump, use Retest Guidelines listed in Appendix 2 to find any re-calibration or re-testing required before returning pump to use.

Service Warnings	
AC Power	The only means of removing AC power is to disconnect the AC power cord. While the AC power cord is attached to the pump and plugged into an AC outlet, live mains voltage is present inside the pump.
Battery Replacement	**For continued protection against fire hazard,** always replace battery pack with same type and model of battery specified in the labeling on the pump.
Clean the Pump	**Always** clean the pump thoroughly before performing maintenance on it. This is recommended by the United States Occupational Safety & Health Administration (OSHA) as a protection from potential biohazard.
Pump Maintenance	Only trained biomedical service personnel may repair, calibrate, and maintain this pump.
Follow Manufacturer's Maintenance Procedures	Always repair and maintain this pump following the manufacturer's recommended instructions in this Service Manual.
Repair Pump in ESD Controlled Work Area	The pump case should only be opened at a work-station with Electro-Static controls, including a grounded mat and wrist-strap.
External DC Power	Any power source connected to the external DC jack must be IEC 60601-1 certified for medical equipment: Type CF, Safety Class II. Connecting external power to the pump creates a medical system; therefore, the user is responsible for compliance with IEC 60601-1 standards. Refer all questions to Medex Technical Service department.
Service Cautions	
Disconnect AC Mains & External DC Power	**Always** disconnect the pump from AC Mains and from External DC power before disassembling the pump for maintenance.
Handle Batteries with Care	**Always** handle the pump's battery pack with care.
Don't Over-tighten Screws	**Never** over-tighten any screws in the pump. Unless otherwise specified, you should torque all screws to *60 in- oz (0.42 Nm)*.
Battery Disposal	**Always** dispose of exhausted NiCad batteries in compliance with all pertinent local, state, national, and international regulations. If unsure of correct methods for compliance, you may return battery packs to Medex for recycling.

Opening & Closing the Pump Housing

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a #1 Phillips head
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Opening the Pump Housing

1. Unplug the AC power cord (also disconnect any external DC power, if in use).
2. If the *pole clamp* is attached to the pump, you must remove it before disassembling the pump. Remove the 2 flat head screws attaching the pole clamp bracket to bottom housing of the pump.
3. Remove the 2 flat head screws from the battery compartment cover, and then remove the cover.
4. Carefully remove battery pack from its compartment, and disconnect its cable from the interconnect board.
5. Remove the 2 pan head screws from the bottom housing of the pump.
6. Carefully separate the two halves of the pump housing (there are three snap tabs across the back).
7. Unplug the *ribbon cable* from **J9** on the main board (in most cases the other end of this ribbon cable is glued or soldered into the interconnect board).

Closing the Pump Housing

1. Before closing the pump housing, be sure the AC and external DC power are disconnected, and the battery pack is removed.
2. Reconnect the *ribbon cable* joining the interconnect board and the main board at **J9**.
3. Be sure all wires are clear of *pinch points* when rejoining the housing halves.
4. There are 3 *snap fit* tabs and slots along the backside of the housing. Align them and close the top & bottom housings together.
5. Screw in the 2 pan head screws which connect the top & bottom housings. Torque these screws to *60 in oz* (0.8 Nm).
6. Orient the battery pack with the circuit board and cable facing the rectangular cutout in the battery compartment.
7. Connect battery cable to the interconnect board. Slide the battery into the compartment.
8. Replace battery cover and secure it with 2 flathead screws. Torque these screws to *60 in oz* (0.8 Nm).
9. If using the *pole clamp*, reattach it to the pump with the 2 flathead screws. Torque these screws to *160 in oz* (2.3 Nm).
10. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Battery Pack

This section defines the steps for removing and replacing the *battery pack* for the 3000 Series infusion pump.

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing the Battery Pack

1. Before removing the battery pack, be sure the AC mains and external DC power are disconnected.
2. Remove the 2 flat head screws from the battery compartment cover, and then remove the cover.
3. Carefully remove battery pack from the compartment, and gently disconnect (pull) its ribbon cable from the interconnect board.

Replacing the Battery Pack

1. Unpack and carefully inspect the battery pack for physical damage.
2. Orient the battery pack with the circuit board and cable facing the rectangular cutout in the battery compartment.
3. Connect battery cable into the interconnect board. Slide the battery into the compartment.
4. Replace battery cover and secure it with 2 flathead screws. Torque these screws to *60 in oz* (0.8 Nm).

Verifying Battery Function After New Battery Replacement

Before returning the 3000 Series pump to service, you must verify the new battery is functioning nominally.

1. Connect the pump to AC power and verify the battery charge indicator is on.
2. Turn ON the pump. From the Main screen, select Biomed program DIAGNOSTICS and go to MONITOR BATTERY STATUS.
3. Wait several minutes from power-on for readings to stabilize and then verify battery charge current is greater than 160 ma (if battery charge reading is greater than 95%, then charge current is reduced to 50 ma or greater).
   a) If $\leq$ 0 ma, then check connections to AC power. [Note: negative current means the battery is discharging.]
   b) If there is no battery information on the MONITOR BATTERY STATUS screen, then check battery connection on battery pack, or connection on the interconnect board.
4. Turn off the pump, but leave it connected to AC power. Allow pump to recharge battery for *at least 10 hours*.
5. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Interconnect Board

This section defines the steps for removing and replacing the *interconnect board* for the 3000 Series infusion pump.

Tools Needed

For this disassembly procedure you will need:

- A *torque screwdriver* with a Phillips head
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing the Interconnect Board

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Unplug the *ribbon cable* from **J9** on the main board (in most cases the other end of this ribbon cable is glued or soldered directly into the interconnect board).
4. Disconnect the *speaker cable* from the interconnect board at **J2**.
5. Disconnect *power supply cable* from interconnect board at **J3**.
6. Remove the 2 pan head screws holding the board, and carefully remove the *interconnect board* from housing.

Replacing the Interconnect Board

[Torque all screws to *60 in oz* (0.8 Nm).]

1. Align the *interconnect board* with the threaded bosses, and press firmly into place.
2. Secure it with the 2 pan head screws.
3. Attach the *speaker cable* to connector **J2**, and the *power supply cable* to connector **J3**.
4. Close the housing and secure with 2 pan head screws.
5. Replace the battery pack, battery cover, and secure with 2 flat head screws.

Verify Interconnect Board Function

Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Speaker

This section defines the steps for removing and replacing the *speaker* for the 3000 Series infusion pump.

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Speaker Removal

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Disconnect the *speaker cable* from the interconnect board at **J2**.
4. Remove the 2 pan head screws & shoulder (or flat) washers holding the speaker to the case, and remove the *speaker* from housing.

Speaker Replacement

[Torque all screws to *60 in oz* (0.8 Nm).]

1. Align the speaker on the round holder, and orient the cable to run toward the interconnect board.
2. Insert the 2 pan head screws & shoulder (or flat) washers and secure the speaker to the housing.
3. Close the housing and secure with 2 pan head screws.
4. Replace the battery pack, battery cover, and secure with 2 flat head screws.

Verifying Speaker Function

After installing the new speaker, you only need to execute power-up testing to verify speaker function.

1. Connect the pump to AC power.
   a) Turn ON the pump.
   b) Listen for power-on tones. Allow power-on self-tests to complete. If no system failure messages appear, then the speaker is good.
2. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

AC Power Supply

This section defines the steps for removing and replacing the *AC Power Supply* for the 3000 Series infusion pump.

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head & small flat blade
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing AC Power Supply

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Remove the power supply shield.
4. Disconnect the interconnect board cable from power supply board at **J2**.
5. Use small flat blade screwdriver to loosen the terminals on the AC input wires, and disconnect the AC input wires from the power supply board at **J1**.
6. Remove the 2 pan head screws securing board to bottom housing, and remove *AC Power Supply Board.*

Replacing the AC Power Supply

1. Align the *AC Power Supply Board* over the threaded bosses, with **J1** in line with the AC input cable.
2. Secure the board with 2 pan head screws. Torque to *60 in oz* (0.8 Nm).
3. Connect the AC Input Wires to **J1** and tighten the 2 terminal screws. Torque to *32 in oz* (0.4 Nm).
4. Reconnect the interconnect board cable to **J2**.
5. Reinstall the Power Supply Shield by sliding it into the notched tabs.
6. Close the housing and secure with 2 pan head screws. Torque to *60 in oz* (0.8 Nm).
7. Replace the battery pack, battery cover, and secure with 2 flat head screws. Torque to *60 in oz* (0.8 Nm).

Verify AC Power Supply Function

After you *replace* the AC Power Supply, you must verify its function with the following steps:

1. Plug the pump into AC power.
2. Verify the AC power indicator lights.
3. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

AC Input Assembly

This section defines the steps for removing and replacing the AC Input Assembly.

Tools Needed

For this disassembly procedure you will need:

- a *¼" open end wrench*
- a *torque screwdriver* with a Phillips head & small flat blade
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing AC Input Module Assembly

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Remove power supply shield.
4. Use small flat blade screwdriver to loosen the 2 screws on the Terminal Block of the power supply.
5. With screwdriver & open end wrench, remove the 2 flathead screws & *nylock* nuts.
6. Slide the *AC Input Module Assembly* from the case.

Replacing AC Input Module Assembly

1. Install *AC Input Module Assembly* with 2 power wires oriented toward the bottom of the housing.
2. Insert the 2 wires into the Terminal block on the power supply.
3. Tighten the 2 screws of the Terminal block. Torque to *32 in oz* (0.4 Nm).
4. Secure with the 2 flathead screws & nylock nuts. Torque to *60 in oz* (0.8 Nm).
5. Reinstall the Power Supply Shield by sliding it into the notched tabs.
6. Close the housing and secure with 2 pan head screws. Torque to *60 in oz* (0.8 Nm).
7. Replace the battery pack, battery cover, and secure with 2 flat head screws. Torque to *60 in oz* (0.8 Nm).

Verifying AC Input Assembly Module Function

After you replace or repair the AC Input Assembly Module, you must verify its nominal function with the following steps:

1. Plug the pump into AC power.
2. Verify the AC power indicator lights.
3. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Bottom Housing Plastic

Tools Needed

For this disassembly procedure you will need:

- a *¼" open end wrench*
- a *torque screwdriver* with a Phillips head and small flat blade
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing the Bottom Housing

1. *Disconnect the pump from AC power source.*
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Unplug the *ribbon cable* from **J9** on the main board (in most cases the other end of this ribbon cable is glued or soldered directly into the interconnect board).
4. Remove the *Interconnect Board*, the *speaker*, the *Power Supply Shield*, the *AC Power Supply*, and the *AC Input Assembly* using the procedures listed above.

Replacing the Bottom Housing

1. The new case bottom should have rubber feet, and IR lens already installed; however, new labels (included) need to be applied.
2. Record the serial number from the old case bottom. Take the new serial number label and type the serial number into the blank field on this label. Take the overlay supplied with the label, remove the backing and apply this overlay to cover/protect the typed serial number label.
3. Remove the backing on the typed serial number label, and apply this to the new case bottom.
4. Attach all new labels to the new case bottom, use the old bottom as a guide for label application.
5. Install the *AC Power Supply*, the *AC Input Assembly*, the *Power Supply Shield*, the *speaker*, and the *Interconnect Board* into the replacement housing using the procedures listed above.
6. Reconnect the *ribbon cable* to **J9** on the main board in the top housing.
7. Close and secure the two halves of the housing, and reinstall the battery pack.
8. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Main Board

This section defines the steps for removing and replacing the *Main Board* for the 3000 Series infusion pump.

Tools Needed

For this disassembly procedure you will need:

- A *torque screwdriver* with Phillips head & small flat head
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing the Main Board

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Disconnect the interconnect ribbon cable from the main board at **J9**.
4. Loosen the 2 terminal block screws connecting the fiber optic back light to the main board, then pull the fiber cable assembly from the terminal block.
5. Disconnect all cable connections on the main board. These include:
   a) *Keypad ribbon cables* at **J10**.
   b) *Motor cable* at **J3**.
   c) *Position pot cable* at **J6**.
   d) *Display cable* at **J12**.
   e) *Ear clip sensor cable* at **J2**.
   f) *Barrel clamp flex circuit* at **J4**.
   g) *Plunger cable* at **J11** and unscrew the cable clamp.
   h) If present, *clip the wire tie securing the 2nd backlight cable.*
6. Remove the 2 pan head screws securing main board, and carefully remove the main board from housing.

Replacing the Main Board

1. Place the new main board into the housing. It should rest in the slot on the extrusion, and align the mounting holes with the 2 stand-offs.
2. Secure the main board with the 2 pan head screws. Torque to *60 in oz* (0.8 Nm).
3. Reconnect all cable and wire connections on the main board. These include:
   a) *Keypad ribbon cables* at **J10**.
   b) *Motor cable* at **J3**.
   c) *Position pot cable* at **J6**.
   d) *Display cable* at **J12**.
   e) *Ear clip sensor cable* at **J2**.
   f) *Barrel clamp flex circuit* at **J4**.
   g) *Plunger cable* at **J11**. Install the cable clamp over the exposed braid of the plunger cable and secure with small pan head screw. Torque screw to 16 *in oz* (0.2 Nm).
   h) If a 2nd fiber optic tail is present on the backlight, connect its cable to J8 on the main board. If you are replacing an older main board (with a black connector at J8), you can discard the backlight adapter cable. After completing the next step, anchor both fiber optic tails to the main board with a wire tie.
4. Insert the back light wires into the main board terminal block. Screw the terminal connector onto the leads with the *flat edge of the LED lens toward the outside edge of the board.* Torque terminal block screws to 32 in oz (0.4 Nm).
   - *NOTE: If you reverse the leads during installation, the back light will not turn ON. You may wish to loosely reassemble the case halves, plug in the battery, and power up pump to check the back light.*
5. Close and secure the two halves of the housing and reinstall the battery pack.
6. Complete recalibration and reconfiguration is required when replacing main board.
7. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Drive Train Assembly

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head & ¼" nut drive
- ¼" wrench
- .002" (.051mm) shim
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Motor Unit (Motor, Worm, Worm Gear)

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until motor mount screws are accessible.
6. Disassemble motor unit as required:
   - For motor or worm, remove two pan head screws and nylock nuts holding the motor. Remove motor and worm. Worm pulls straight off of motor shaft.
   - For worm gear (plastic gear on leadscrew). Pull staight off of leadscrew shaft.
7. Remove pan head screw holding tubing guides and remove the tubing guides. Note orientation of each tubing guide.

Replacement

1. Reassemble motor unit:
   - For motor/worm, slide worm onto motor shaft. Rotate motor to align mounting holes with holes in motor plate. Insure the motor is positioned for the wires to properly reach the main board. Secure motor with two pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
   - For worm gear, align "D" with shaft and press onto leadscrew until centered over worm.
2. Carefully slide the extrusion (drive train assembly) back into case.
   - Insure right end plate on extrusion does not damage ear clip sensor.
   - Insure plunger cable comes out between middle boss and boss by the motor.
   - Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
3. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to *100 in oz* (1.2 Nm).
4. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
5. Reinstall main board per main board section above.
6. Close pump housing per housing section above.

Position Potentiometer

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until flat head screw in right end plate is accessible.
6. Remove small flat head screw holding position potentiometer (pot).
7. On the carriage remove pan head screw, washer, and nylock nut holding the post of the pot. (It may be necessary to reposition carriage by moving the plunger head.)
8. Remove three flat head screws holding motor assembly on extrusion and rotate out of way.
9. Slide position pot out of the extrusion.

Replacement

1. Slide new position pot into extrusion.
2. Clean small flat head screw (or use a new screw), apply Loctite 242 (mild thread-locking adhesive) to screw, and secure pot to right end plate of extrusion assembly. Torque **only** to *16 in oz* (0.2 Nm).
3. Secure motor assembly on extrusion with three flat head screws. Torque to *100 in oz* (1.2 Nm).
4. Slide post of position pot up to carriage. Insert pan head screw through hole in carriage arm, then through washer. Start the nylock nut onto the screw. Insert 0.002" shim between pot's post and the washer, then tighten the nut until slack is removed. Do not over-tighten nut. Remove shim and check if flat washer can move (spin) freely, if not loosen nut slightly.
5. Carefully slide the extrusion (drive train assembly) back into case.
   - Insure right end plate on extrusion does not damage ear clip sensor.
   - Insure plunger cable comes out between middle boss and boss by the motor.
   - Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
6. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to *100 in oz* (1.2 Nm).
7. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
8. Reinstall main board per main board section above.
9. Close pump housing per housing section above.

Clutch Assembly

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head & ¼" nut drive
- ¼" wrench
- .002" (.051mm) shim
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Leadscrew

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until nylock nut holding leadscrew on right end plate is accessible.
6. Pull the plastic worm gear off the end of leadscrew near motor.
7. Remove three flat head screws holding motor assembly on extrusion, and pull off motor assembly.
8. Slide carriage rod out of the carriage.
9. Move the plunger head/carriage in about 1" (2.5cm) from the right end plate. Hold onto the "D" side of the leadscrew and use ¼" wrench to remove nylock nut holding leadscrew and the flat brass washer.
10. Slide extrusion in slightly until leadscrew clears right end plate, then pull off the thrust bearings.
11. Squeeze the plunger lever to open clutch and pull leadscrew out of carriage.

Replacement

1. Apply light coating of STP poly-plus (lithium) grease to leadscrew. Squeeze plunger lever to open clutch and insert leadscrew until it sticks slightly through the carriage.
2. Install thrust bearing assembly (flat washer, bearings, flat washer) onto end of leadscrew and pull on plunger head to feed leadscrew through the right end plate. Insure nylon shoulder washer is still in place on right end plate.
3. Place brass washer over the leadscrew and start nylock nut. Insert .002" shim between the brass washer and shoulder washer and tighten the nut. Do not over-tighten nut. Remove shim and check if brass washer can move (spin) freely, if not loosen nut slightly.
4. Slide carriage rod through carriage and seat into hole in right end plate.
5. Slide motor assembly over leadscrew and align carriage rod with motor assembly bracket. Secure motor assembly on extrusion with three flat head screws. Torque to *100 in oz* (1.2 Nm).
6. Align "D" of worm gear with leadscrew shaft and press onto leadscrew until gear is centered over the motor worm.
7. Carefully slide the extrusion (drive train assembly) back into case.
   - Insure right end plate on extrusion does not damage ear clip sensor.
   - Insure plunger cable comes out between middle boss and boss by the motor.
   - Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
8. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to *100 in oz* (1.2 Nm).
9. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
10. Reinstall main board per main board section above.
11. Close pump housing per housing section above.

Clutch or Clutch Cam

Additional Tools Needed

For this disassembly procedure you will need:

- Safety glasses
- Needle nose pliers

Removal

1. Remove leadscrew per procedure above.
2. Use needle nose pliers (or hemostats) to remove e-ring from cam in carriage plate.
3. Using ¼" open end wrench and Phillips screw driver, remove three pan head screws with nylock nuts holding the carriage plate.
4. Use needle nose pliers to remove either:
   - the clutches, use caution in separating clutches because of spring.
   - the cam, pull straight out and separate from square shaft.

Replacement

1. For replacement of:
   - the cam, first insure the shaft is seated to the plunger lever, then press the cam gear on the shaft.
   - the clutches, put the clutch halves together (closed) and press the spring into place, then slide the clutch halves into the carriage.
2. Feed the pan head screws though the carriage then the carriage plate, then secure with nylon nuts. Nuts should be on top of the carriage plate not the carriage. Torque to *100 in oz* (1.2 Nm).
3. Snap e-ring over cam sticking through carriage plate.
4. Replace leadscrew per procedure above.

Plunger Cable

Removal

1. Remove leadscrew per procedure above.
2. Using ¼" open end wrench and Phillips screw driver, remove three pan head screws with nylock nuts holding the carriage plate. Pull plate with cam and square shaft attached.
3. Open plunger case right per procedure below.
4. Unplug the plunger cable from plunger board and pull cable out of slot in force mount and plunger tube.
5. At the carriage, turn plunger cable connector in line with the cable, and pull cable out through plunger head.

Replacement

1. Take the new plunger cable, with the smaller exposed braid area towards the carriage, turn connector in line with the cable, then thread the cable through the plunger tube.
2. Plug the cable into the plunger board, then press the braided portion into the slot of the force mount and plunger tube. This should leave about 2" (5cm) of cable sticking out the notched end of the plunger tube.
3. Press the square shaft on the cam, the cam through the carriage plate (check orientation of plate) and snap the e-ring on the cam.
4. Slide carriage plate with clutch cam and shaft into plunger tube.
5. Feed the pan head screws though the carriage then the carriage plate, then secure with nylon nuts. Nuts should be on top of the carriage plate not the carriage. Torque to *100 in oz* (1.2 Nm).
6. Close plunger case per procedure below.
7. Replace lead screw per procedure above.

LCD and Back Light

This section defines the steps for removing and replacing the *LCD Display and Back Light* for the 3000 Series infusion pump.

Tools Needed

For this disassembly procedure you will need:

- A *¼" open end wrench*
- A *torque screwdriver* with Phillips head & small flat head
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing LCD and/or Back Light Assembly

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Disconnect the display cable from the main board at **J12**.
4. Use small flat blade screwdriver to loosen the 2 screws connecting the *fiber optic* back light to the main board. Then pull the fiber cable assembly from the terminal block.
5. If the back light has a 2nd fiber optic tail, cut the wire tie anchoring its connecting cable and separate the 2nd tail from the connecting cable.
6. With ¼" open end wrench, remove the 2 *nylock nuts* securing the display.
7. Carefully lift the display assembly from the *top housing*.
8. Slide the back light and spacer from the display assembly.

Replacing the LCD and/or Back Light Assembly

1. Remove the protective plastic film from the new display's glass.
2. Remove the tape which holds the plastic spacer inside the new display, and slide out the spacer. Discard the white plastic spacer.
3. If the backlight has one fiber optic tail, then you will use two clear plastic spacers in the next step. If your backlight has two fiber optic tails, then you will use only one clear plastic spacer in the next step.
4. Place the clear plastic spacer(s) on top of the backlight with the *white side* of the back light facing up and the silver side down.
5. Gently slide the back light and spacer together into the display with the clear plastic spacer toward the display glass.
6. Orient the display with the back light tail on the side with the keypad cables. Verify there is not lint or dirt on the display.
7. Slide the display onto the ribs in the top of the top housing and over the spacers/studs. Secure the display assembly with the 2 nylock nuts and tighten with ¼" wrench.
8. Reconnect the *display cable* to the main board at **J12.**
9. If a 2nd fiber optic tail is present on the backlight, clip the lead on the LED of the shorter fiber optic tail to match the length of the shorter tail's LED on the removed backlight. Note: the longer fiber optic tail's LED requires longer leads. Connect the shorter fiber optic tail to the round connector on the cable. Be sure to orient the lead closest to the flat edge of the LED into the terminal touching the MELF resistor embedded in the round connector. After completing the next step, anchor both fiber optic tails to the main board with a wire tie.
10. Insert the back light wires into the main board terminal block. (When replacing the back light, trim the LED leads to about ½" in length.] Screw the terminal connector onto the leads with the *flat edge of the LED lens toward the outside edge of the board.* Torque terminal block screws to 32 in oz (0.4 Nm).
    - *NOTE: If you reverse the leads during installation, the back light will not turn ON. You may wish to loosely reassemble the case halves, plug in the battery, and power up pump to check the back light.*
11. Close and secure the two halves of the housing and reinstall the battery pack.

Verify LCD & Back Light Assembly Function

1. Plug the pump into AC power and turn it ON.
2. Watch the screen during startup and self-testing. [Note: you may wish to adjust the display contrast, see chapter on calibration and adjustment.]
3. After self-testing completes, set the pump in a darkened area and verify the back light is functioning.
4. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Keypad

This section defines the steps for removing and replacing the Keypad.

Tools Needed

For this disassembly procedure you will need:

- a *¼" open end wrench*
- a *torque screwdriver* with a Phillips head & small flat blade
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Removing the Keypad

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Disconnect the interconnect ribbon cable from **J9** on the main board.
4. Loosen the 2 terminal block screws connecting the fiberoptic back light to the main board. Then, carefully pull the leads from the connector. If a 2nd backlight LED is present, disconnect its cable at the main board. and clip the wire tie securing it to the main board.
5. Disconnect the keypad cables at **J10** on the main board.
6. Disconnect the display cable at **J12** on the main board.
7. Remove the 2 pan head screws securing the main board, and then loosen the main board. It is not necessary to remove the main board, or disconnect all cables from it, to access the keypad.
8. With ¼" open end wrench, remove the 2 *nylock nuts* securing the display board, and remove the display from the top housing.
9. With ¼" *open end wrench*, remove one hex head standoff nearest to the motor, and carefully slide out the keypad ground tab from between the top housing boss and the extrusion.
10. Press on inside of clear lens (window) to loosen keypad and peel keypad from top housing.

Replacing the Keypad

Keypad is NOT Flexible	Whenever handling the keypad, always ensure it remains *flat*. Bending the keypad can damage keys or break LED contacts.

1. Clean the clear lens with a soft cloth. Insure there is no lint or fingerprints on the lens.
2. Insure inside of new keypad window is clear of lint or fingerprints.
3. Remove backing from the keypad. Feed the 3 keypad cables through the housing window. Slide the clear lens into the cutout of the case top.
4. Align the keypad and carefully press into recess in the case top. Keep the keypad as flat as possible.
5. Slide the keypad ground tab between the extrusion and the top housing boss. Be sure the *black side* of the tab faces toward the extrusion. Replace the hex head standoff into the extrusion securing the ground tab. Torque to *100 in oz* (1.2 Nm).
6. Slide the display assembly into the ribs on the top housing, and secure it with 2 *nylock nuts*.
7. Reposition the main board and secure with 2 pan head screws. Torque to *60 in oz* (0.8 Nm).
8. Reconnect display cable to J12, keypad cables to J10.

9. Insert the back light wires into the main board terminal block. (When replacing the back light, trim the LED leads to about ½" in length.] Screw the terminal connector onto the leads with the *flat edge of the LED lens toward the outside edge of the board.* Torque terminal block screws to 32 in oz (0.4 Nm). If present, connect the 2nd backlight LED's cable to J8.
   - *NOTE: If you reverse the leads during installation, the back light will not turn ON. You may wish to loosely reassemble the case halves, plug in the battery, and power up pump to check the back light.*
10. If a 2nd backlight LED is present, secure the fiber optic cable to the main board with a wire tie.
11. Close the pump case and reinstall the battery pack.
12. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Syringe Barrel Clamp Assembly

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head & 1/16" hex head
- ¼" wrench
- small vise-grip pliers
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Barrel Clamp Head

Removal

1. Lift barrel clamp head until screw is accessible then use vise grips to clamp near base of barrel clamp rod to hold it in place.
2. Using a 1/16" hex wrench, remove hex head screw from barrel clamp head.
3. Pull barrel clamp head off of the barrel clamp rod.

Replacement

1. Align the hole in the barrel clamp rod with the barrel clamp head, and press the head onto the rod.
2. Secure the barrel clamp head with the 1/16" hex head screw. Torque to *60 in oz* (0.8 Nm)

Verify Function

1. Verify barrel clamp head moves up and down, and will rotate when fully extended.
2. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Barrel Clamp Body Assembly

Removal

1. Remove barrel clamp head per above
2. Open pump housing per pump housing section above.
3. Using a ¼" wrench and Phillips screwdriver, remove two pan head screws with nylock nuts which hold the barrel clamp assembly. These screws are located on the right end plate of the drive train assembly.
4. Unplug the barrel clamp flex circuit from J4 of the main board.
5. Gently slide barrel clamp assembly out of the case avoiding the fingers extending from the right end plate around the plunger tube.
6. Remove small screw holding the pot to the barrel clamp assembly.
7. Carefully lift pot up off alignment bosses and out of fingers on the slide.

Replacement

1. Align new pot into fingers of slide on the barrel clamp assembly and press onto bosses.
2. Secure pot with small screw. Tighten until screw is flush with pot. [Do not over-tighten.]
3. Carefully slide barrel clamp body assembly into case. Push the rod through the hole in top of the case.
4. Secure barrel clamp assembly with two pan head screws with nylock nuts. Torque to *100 in oz* (1.2 Nm).
5. Plug barrel clamp flex circuit into J4 of the main board.
6. Close pump housing per housing section above.
7. Replace barrel clamp head and verify function per above.

Ear Clip, Handle & Guide

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head & ¼" nut drive
- needle nose pliers (two pairs)
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Ear Clip

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Use one pair of needle nose pliers to press the ear clip sleeve towards the case wall, then use a second set of pliers (or hemostats) to pull the e-ring off of the ear clip. [Note, on older pumps sleeve is not present, so use 1st set of pliers to pull spring towards the case wall.]
3. Slide the ear clip out of the top housing assembly.

Replacement

1. Partially insert new ear clip through side of case, then slide the spring onto shaft of ear clip.
2. Slide sleeve over ear clip with hollow end of sleeve towards the spring.
3. Insure the ear clip faces the "V" groove in the case top, then press the ear clip into the case. Use one pair of needle nose pliers to compress the sleeve (and/or spring) and use a second set of needle nose (or hemostats) to snap e-ring into groove on the ear clip.
4. Pull on the ear clip and release it. Verify that the ear clip moves smoothly out and is pulled back flush to the case by the spring when released.
5. Close pump housing per housing section above.

Ear Clip Optical Sensor

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until ear clip sensor is visible.
6. Remove pan head screw holding sensor and remove the ear clip optical sensor.

Replacement

1. On the new ear clip sensor, look at the old sensor then use wire cutters to carefully cut a portion of the plastic tab/mounting hole to allow clearance for the display connector.
2. Slide ear clip sensor onto post in case top, with grey side of sensor away from the display.
3. Secure the sensor with the pan head screw. Torque to *100 in oz* (1.2 Nm).
4. Carefully slide the extrusion (drive train assembly) back into case.
   - Insure right end plate on extrusion does not damage ear clip sensor.
   - Insure plunger cable comes out between middle boss and boss by the motor.
   - Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.

5. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to *100 in oz* (1.2 Nm).
6. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
7. Reinstall main board per main board section above.
8. Close pump housing per housing section above.

Handle

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until two handle screws are visible.
6. Remove two pan head screw holding handle and remove the handle.

Replacement

1. Verify o-rings seals are in each handle recess on case top.
2. Place new handle on case top and secure with two pan screws through the inside of case.
3. Carefully slide the extrusion with plunger tube back into the case.
4. Carefully slide the extrusion (drive train assembly) back into case.
   - Insure right end plate on extrusion does not damage ear clip sensor.
   - Insure plunger cable comes out between middle boss and boss by the motor.
   - Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
5. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to *100 in oz* (1.2 Nm).
6. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
7. Reinstall main board per main board section above.
8. Close pump housing per housing section above.

Tubing Guide

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until three tubing guide screws are visible.
6. Remove pan head screw holding tubing guides and remove the tubing guides. Note orientation of each tubing guide.

Replacement

1. Place each tubing guide onto case top and secure with a pan head screw and nylon washer. The bumps on the case top help insure correct orientation of each guide. Torque to *60 in oz* (0.8 Nm).

2. Carefully slide the extrusion (drive train assembly) back into case.
   - Insure right end plate on extrusion does not damage ear clip sensor.
   - Insure plunger cable comes out between middle boss and boss by the motor.
   - Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
3. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to *100 in oz* (1.2 Nm).
4. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and nylock nuts. Torque to *100 in oz* (1.2 Nm).
5. Reinstall main board per main board section above.
6. Close pump housing per housing section above.

Plunger Case Assembly

Tools Needed

For this disassembly procedure you will need:

- a *torque screwdriver* with a Phillips head & 2.5mm hex head
- needle nose pliers
- safety glasses
- **Always work at an electrostatic-controlled work station** when disassembling the pump.

Plunger lever

Removal

1. Remove pan head screw from lever.
2. Pull plunger lever off the lever gear.

Replacement

1. Position new plunger lever onto lever gear and secure with pan head screw. Torque to *60 in oz* (0.8 Nm).

Plunger Case Disassembly

Wear *safety glasses* during this procedure as there are springs within this assembly which may be a hazard.

Disassembly

1. Stand the pump up on its left side so that the plunger assembly points vertically up. Squeeze the plunger lever and position the plunger driver for disassembly.
2. Remove three pan head screws holding the plunger case halves together (do not remove screw on lever).
3. Remove the plunger case right and remove the plunger case seal. The lever gear will be attached to the plunger case right. The square shaft may come out with plunger case right; if so, pull the shaft out of the lever gear and slide the shaft down the plunger tube into gently press into the cam.

Reassembly

1. Remove any slack in movement of square shaft by turning counter-clockwise. With plunger lever positioned up against long rib on plunger case right, join the two case halves together pressing the lever gear over the square shaft.
2. Start the three pan head screws into the plunger case halves, with the long screw into the tall rib of the case.
3. Before tightening, press the plunger case seal into the gaps between the case halves. Insure the seal is positioned properly between the halves then tighten the plunger case screws. Torque to *60 in oz* (0.8 Nm).
4. Follow retest guidelines listed in appendix to verify pump functionality before returning it to use.

Cam Gear and Timing Plate

Wear *safety glasses* during this procedure as there are springs within this assembly which may be a hazard.

Removal

1. Open the plunger case halves per above.
2. Lift cam gear off of pin.
3. Remove push block.

4. Press timing plate upward and lift carefully to remove timing plate spring and timing plate. Note, the timing plates are asymmetrical (left and right handed).

Replacement

1. Rotate the right flipper until it stops against the "V" groove on the plunger case.
2. Insert the spring into the timing plate right. Slide spring over the post in the side wall of the plunger case.
3. Slowly lower timing plate into the plunger case slot – as far down the slot as possible toward the optical sensor on the plunger board – while lining up the gears.
4. Repeat this process for the left flipper and left timing gear.
5. Place the push block on top of the timing plate
6. Place cam gear over pin (check assembly drawing for orientation) and up against push block.
7. Close plunger case halves per above.

Flipper and Flipper Gear

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Use the needle nose pliers to compress the flipper shaft inside the flipper gear. Gently pull on the flipper while compressing the shaft.
3. Slide the O-ring seal off of the flipper. (Inspect the O-ring replace if damaged; otherwise, clean with soap and water.)

Replacement

1. Slide O-ring seal over new flipper.
2. Insert flipper through the plunger case and snap onto the flipper gear. (Insure gear recess faces out from case – if gear is installed incorrectly then flipper will not snap in place. If flipper gear is damaged replace flipper gear.)
3. Install timing plates per above and reassemble plunger case halves.

Plunger Board

Note: Insure plunger head is fully extended away from pump housing before starting.

Additional Tools Needed

For this disassembly procedure you *may* also need:

- .002" (.051mm) shim

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on plunger board.
3. Using a Phillips screwdriver, remove pan head screw with washer from the force mount assembly.
4. On newer assemblies it is not necessary to remove float plate seal and float plate. Gently try to pull plunger case left towards the pump. If it comes apart skip to step 7 below, otherwise remove float plate seal and float plate.
5. Grab float plate seal with pliers (or hemostats) and pull off from plunger case left. (Float plate seal is glued in place and may be damaged in removal.)
6. Using a metric 2.5mm hex wrench , remove the screw holding the float plate.
7. Slide plunger case left toward pump until plunger board is accessible, then remove plunger board.

Replacement

1. Insert new plunger board into plunger case left. (Insure board sits on two guide pins and does not interfere with flipper gears.)
2. Slide the plunger case left up and over the force mount assembly. Secure in place with the flat washer and pan head screw. Torque to *100 in oz* (1.2 Nm).
3. Connect force sensor cable to the plunger board at connector J1 and press excess cable flat against board.
4. Connect plunger cable to plunger board connector J2, and check to insure cable remains in slot through force mount and plunger tube.
5. If you did not remove float plate/seal skip to step 7; otherwise, place float plate into opening in plunger case left and start 2.5mm hex screw into this assembly. Slide a .002" shim between float plate and the wall of the plunger case. Tighten screw and torque to *100 in oz* (1.2 Nm), then remove shim.
6. Use sharp tool or knife to clean slot for seal. If seal was damaged, replace with a new seal. Place small drops of Loctite 454 (cyanoacrylate adhesive) at four points in the slot and then press the seal into place.
7. Install timing plates and reassemble plunger case per above.

Force Sensor

Note: Insure plunger head is fully extended away from pump housing before starting.

Additional Tools Needed

For this disassembly procedure you will also need:

- .002" (.051mm) shim

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on plunger board.
3. Using a Phillips screwdriver, remove pan head screw with washer from the force mount assembly.
4. On newer assemblies it is not necessary to remove float plate seal. Gently try to pull plunger case left towards the pump. If it comes apart skip to step 6 below, otherwise remove float plate seal.
5. Grab float plate seal with pliers or hemostats and pull off from plunger case left. (Float plate seal is glued in place and may be damaged in removal.)
6. Using a metric 2.5mm hex wrench , remove the screw holding the float plate.
7. Slide plunger case left toward pump until the hex head screw is accessible on the force mount assembly.
8. Using a metric 2.5mm hex wrench , remove the screw holding the force sensor onto the force mount. Note the orientation of the cable on the force mount.

Replacement

1. Install the new force sensor onto the force mount bracket with the 2.5mm hex screw. (Insure the cable of the force sensor faces towards the plunger PCB and connector J1.) Torque to *100 in oz* (1.2 Nm).
2. Slide the plunger case left up and over the force mount assembly. Secure in place with the flat washer and pan head screw. Torque to *100 in oz* (1.2 Nm).
3. Connect force sensor cable to the plunger board at connector J1 and press excess cable flat against board.
4. Connect plunger cable to plunger board connector J2, and check to insure cable remains in slot through force mount and plunger tube.
5. Place the float plate into opening in plunger case left and start 2.5mm hex screw into this assembly. Slide a .002" shim between float plate and the wall of the plunger case. Tighten screw and torque to *100 in oz* (1.2 Nm), then remove shim.
6. If you did not remove float plate seal skip to step 7; otherwise, use sharp tool or knife to clean slot for seal. If seal was damaged, replace with a new seal. Place small drops of Loctite 454 (cyanoacrylate adhesive) at four points in the slot and then press the seal into place.
7. Install timing plates and reassemble plunger case per above.

Left Plunger Case

Note: Insure plunger head is fully extended away from pump housing before starting.

Additional Tools Needed

For this disassembly procedure you will also need:

- .002" (.051mm) shim

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Remove plunger flippers and gears per above.
3. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on plunger board.
4. Using a Phillips screwdriver, remove pan head screw with washer from the force mount assembly.
5. On newer assemblies it is not necessary to remove float plate seal. Gently try to pull plunger case left towards the pump. If it comes apart skip to step 8 below, otherwise remove float plate seal.
6. Grab float plate seal with pliers or hemostats and pull off from plunger case left. (Float plate seal is glued in place and may be damaged in removal.)
7. Using a metric 2.5mm hex wrench , remove the screw holding the float plate.
8. Slide plunger case left toward pump until the two small flat head screws are accessible on the force mount. Unscrew two flat head screws on force mount. Pull plunger cable out of slot on force mount bracket and plunger tube. Slide off the force mount assembly from the plunger tube.
9. Slide plunger case left off of plunger tube.

Replacement

1. Install flippers and flipper gears per above into new plunger case left.
2. Transfer plunger board into new plunger case.
3. Slide new plunger case left onto plunger tube. (Insure case is correctly oriented.)
4. Thread plunger cable through force mount assembly and slide assembly onto plunger tube align screw holes and cable slot. Apply (mild thread-locking adhesive) Loctite 242 to flat head screws and secure the force mount to the plunger tube. Torque to *100 in oz* (1.2 Nm). [Be careful not to cross-thread screws.]
5. Slide the plunger case left up and over the force mount assembly. Secure in place with the flat washer and pan head screw. Torque to *100 in oz* (1.2 Nm).
6. Connect force sensor cable to the plunger board at connector J1 and press excess cable flat against board.
7. Press plunger cable into slot though plunger tube, force mount, and plunger case left. Insure exposed braid of cable touches metal on force mount or plunger tube.
8. Connect plunger cable to plunger board connector J2, and check to insure cable remains in slot through force mount and plunger tube.
9. Place the float plate into opening in plunger case left and start 2.5mm hex screw into this assembly. Slide a .002" shim between float plate and the wall of the plunger case. Tighten screw and torque to *100 in oz* (1.2 Nm), then remove shim.
10. Use a new seal. Place small drops of Loctite 454 (cyanoacrylate adhesive) at four points in the slot and then press the seal into place.
11. Install timing plates and reassemble plunger case per above.

Notes

PART 5: CALIBRATION & ADJUSTMENT

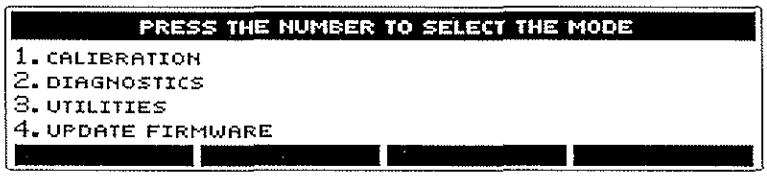
Using Biomed Calibration

This chapter explains the use of Biomed *Calibration* for the calibration of internal sensors of the 3000 Series infusion pumps.

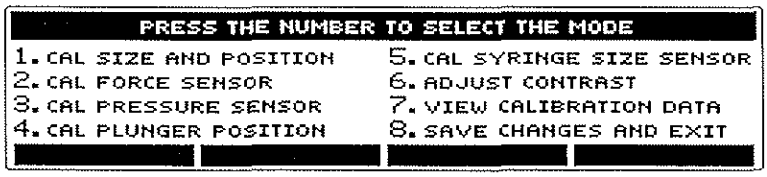
Biomed Calibration

In order to complete the calibration of the 3000 Series infusion pumps, you need the Medex 3000 Series Calibration Kit. This kit contains the following:
1 ea – 3000 Series Calibration Kit: *Small Calibration Slug, Large Calibration Slug, & Force Gauge*

Below is the first Biomed SELECT THE MODE screen.



Use the number buttons to select CALIBRATION which calls up the Biomed *Calibration* SELECT THE MODE screen.


PRESS THE NUMBER TO SELECT THE MODE
1. CAL SIZE AND POSITION
2. CAL FORCE SENSOR
3. CAL PRESSURE SENSOR
4. CAL PLUNGER POSITION
5. CAL SYRINGE SIZE SENSOR
6. ADJUST CONTRAST
7. VIEW CALIBRATION DATA
8. SAVE CHANGES AND EXIT

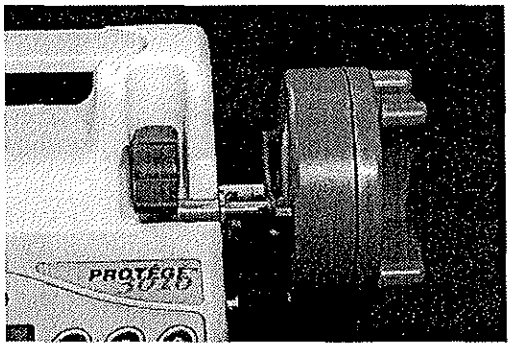
Below is table which summarizes the options available for calibration.

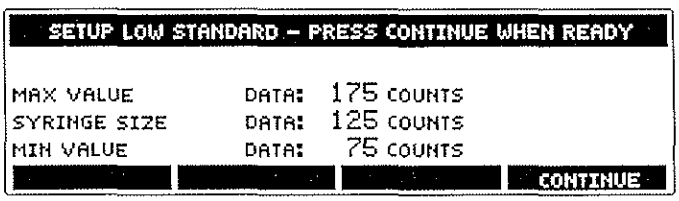
Calibration Option	What it Controls
Calibrate (Syringe) Size and Position	Performs concurrent adjustment of syringe size & position sensors settings. This requires Medex "calibration slugs".
Calibrate Force Sensor	Performs adjustment of force sensor settings.
Calibrate Pressure Sensor	This is a future option of the 3000 Series pumps. .
Calibrate Plunger Position Sensor	Performs adjustment of plunger position sensor settings.
Calibrate Syringe Size Sensor	Performs adjustment of syringe size sensor setting.
Adjust Contrast	Varies the onscreen contrast of the LCD. The pump is shipped with a "factory average" default. You may set it above or below for "comfortable" viewing
View Calibration Data	Displays the "current" calibration data settings.
Save Changes and Exit	Saves the new calibration settings and then returns to the main Biomed screen.

Calibrate (Syringe) Size and Position

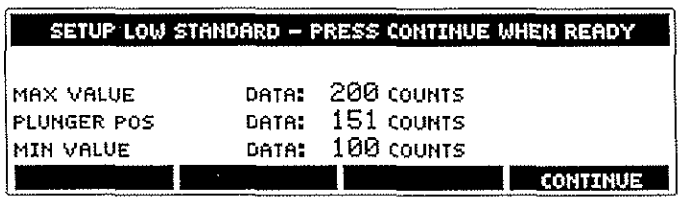
This procedure calibrates both the *syringe size* sensor and the *syringe position* sensor. The *syringe size sensor* is part of the barrel clamp assembly and measures the syringe barrel external diameter allowing the software to determine the syringe size loaded onto the pump. The *syringe position sensor* is part of the drive train assembly and measures the plunger head position allowing the software to determine the empty position and plunger head travel.

Performing Both Size & Position Calibration

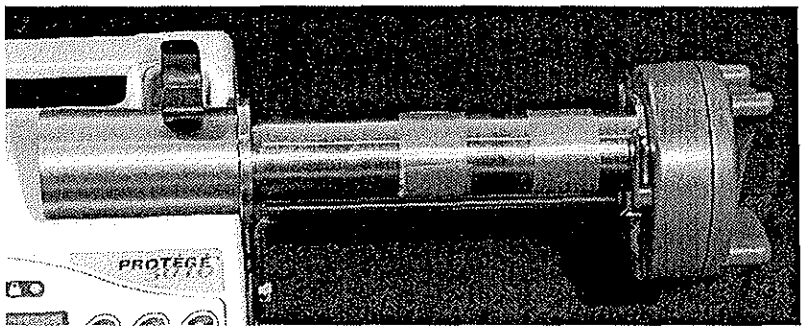


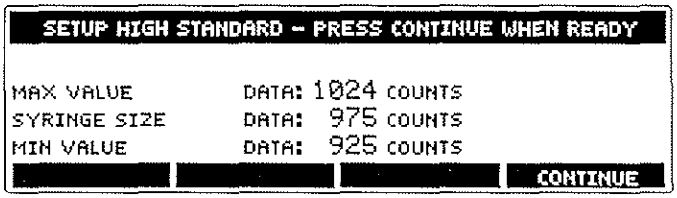

SETUP LOW STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 175 COUNTS
SYRINGE SIZE DATA: 125 COUNTS
MIN VALUE DATA: 75 COUNTS
CONTINUE

1. Load the small calibration slug into the barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press the **Continue** button to calibrate the small size.

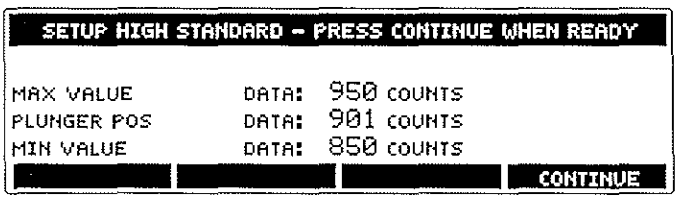

SETUP LOW STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 200 COUNTS
PLUNGER POS DATA: 151 COUNTS
MIN VALUE DATA: 100 COUNTS
CONTINUE

2. Squeeze the plunger lever to hold the flippers open, move the plunger head against the small slug, and press the **Continue** button to calibrate the low position.




SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 1024 COUNTS
SYRINGE SIZE DATA: 975 COUNTS
MIN VALUE DATA: 925 COUNTS
CONTINUE

3. Load the large calibration slug into barrel clamp . Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press the **Continue** button to calibrate large size.

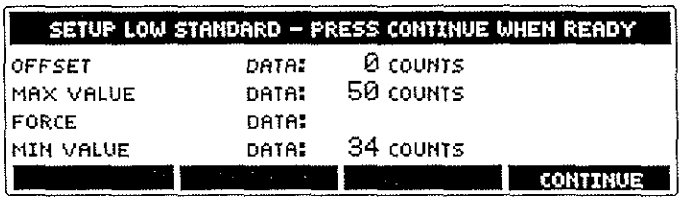

SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 950 COUNTS
PLUNGER POS DATA: 901 COUNTS
MIN VALUE DATA: 850 COUNTS
CONTINUE

4. Load the large calibration slug into barrel clamp. Squeeze the plunger lever to hold the flippers open, move the plunger head against the large slug, and press the **Continue** button to calibrate high position.

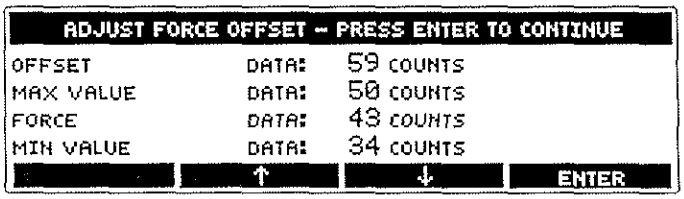
5. You return to the Calibration SELECT THE MODE screen. You may calibrate another mode, choose to SAVE CHANGES AND EXIT, or press the **Back** button to return to the main Biomed SELECT THE MODE screen.

Calibrate Force Sensor

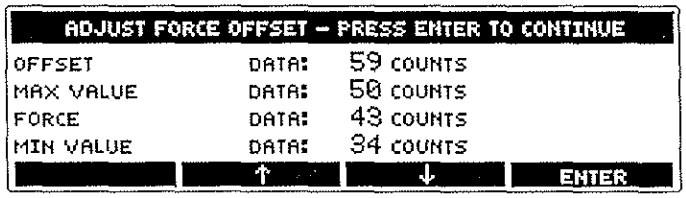
Select and open BIOMED from the main screen. Then, select CALIBRATION from the *Biomed* SELECT THE MODE screen. Select CAL FORCE SENSOR from the *Calibration* SELECT THE MODE screen.


SETUP LOW STANDARD - PRESS CONTINUE WHEN READY
OFFSET DATA: 0 COUNTS
MAX VALUE DATA: 50 COUNTS
FORCE DATA:
MIN VALUE DATA: 34 COUNTS
CONTINUE

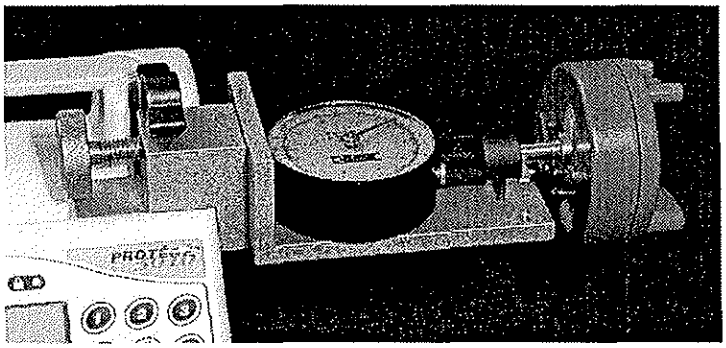
1. Insure nothing is loaded in the plunger head, press the **Continue** button, and wait until force sensor zero is finished.

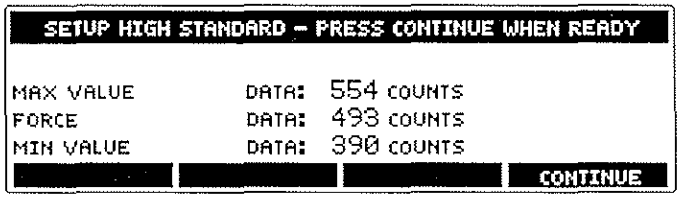


2. Pump then *auto-zeroes* the force sensor's offset. This takes about 40 seconds. [Do not use arrow keys.]



3. Press the **Enter** button when zeroing is complete.




SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 554 COUNTS
FORCE DATA: 493 COUNTS
MIN VALUE DATA: 390 COUNTS
CONTINUE

4. Press the zero button on the force gauge. Load the force gauge under the barrel clamp resting flush on the case top. Insure the flippers are below (closed) the force gage head, and use the thumbscrew to adjust the gauge to 10 lbs ±0.2, then press the **Continue** button. The force calibration is complete.

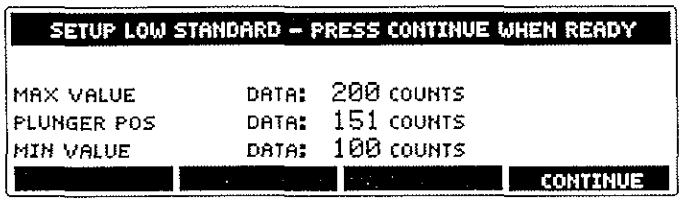
5. You return to the Calibration SELECT THE MODE screen. You may calibrate another mode, choose to SAVE CHANGES AND EXIT, or press the **Back** button to return to the main Biomed SELECT THE MODE screen.

Calibrate Pressure Sensor (Future Option)

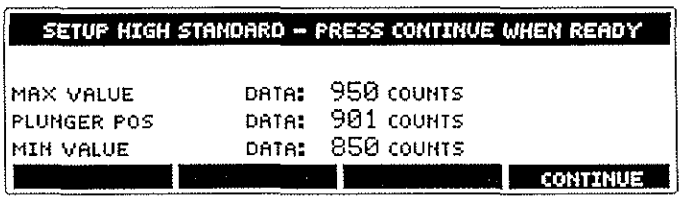
Do not use, this is a "future option" of the 3000 Series

Calibrate Plunger Position

Select and open BIOMED from the main screen. Then, select CALIBRATION from the Biomed SELECT THE MODE screen. Select CAL PLUNGER POSITION from the Calibration SELECT THE MODE screen.


SETUP LOW STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 200 COUNTS
PLUNGER POS DATA: 151 COUNTS
MIN VALUE DATA: 100 COUNTS
CONTINUE

1. Load the small calibration slug into the barrel clamp. Squeeze the plunger lever to hold the flippers open, move the plunger head against the small slug, and press the **Continue** button to calibrate the low position.

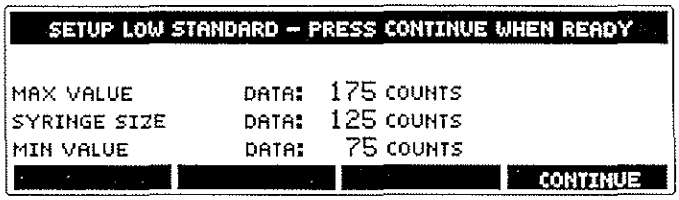

SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 950 COUNTS
PLUNGER POS DATA: 901 COUNTS
MIN VALUE DATA: 850 COUNTS
CONTINUE

2. Load the large calibration slug into barrel clamp. Squeeze the plunger lever to hold the flippers open, move the plunger head against the large slug, and press the **Continue** button to calibrate high position.

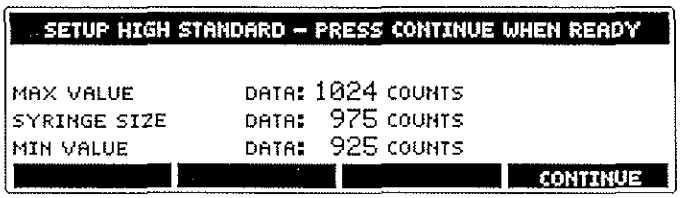
3. You return to the Calibration SELECT THE MODE screen. You may calibrate another mode, choose to SAVE CHANGES AND EXIT, or press the **Back** button to return to the main Biomed SELECT THE MODE screen.

Calibrate Syringe Size Sensor

Select and open BIOMED from the main screen. Then, select CALIBRATION from the Biomed SELECT THE MODE screen. Select CAL SYRINGE SIZE from the Calibration SELECT THE MODE screen.


SETUP LOW STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 175 COUNTS
SYRINGE SIZE DATA: 125 COUNTS
MIN VALUE DATA: 75 COUNTS
CONTINUE

1. Load the small calibration slug into the barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press the **Continue** button.


SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY
MAX VALUE DATA: 1024 COUNTS
SYRINGE SIZE DATA: 975 COUNTS
MIN VALUE DATA: 925 COUNTS
CONTINUE

2. Load the large calibration slug into barrel clamp . Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press the **Continue** button to calibrate large size.

3. You return to the Calibration SELECT THE MODE screen. You may calibrate another mode, choose to SAVE CHANGES AND EXIT, or press the **Back** button to return to the main Biomed SELECT THE MODE screen.

Adjust Contrast (Voltage) Setting

The factory default contrast voltage setting is **00BF** (however this value may vary for different LCD display manufactures). This is the nominal setting for most lighting conditions and may be adjusted higher or lower.

Select and open BIOMED from the main screen. Then, select CALIBRATION from the Biomed SELECT THE MODE screen. Select ADJUST CONTRAST from the Calibration SELECT THE MODE screen.

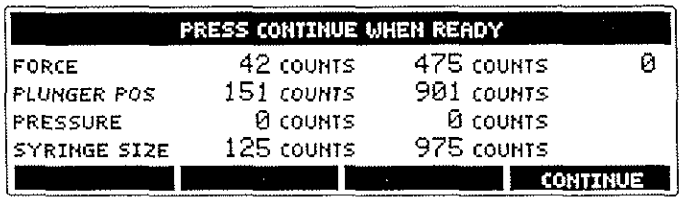
1. Use the "↑" and "↓" keys to setup the *contrast voltage*. Up arrow increases contrast.

2. When ready, press the **Enter** button to accept the new contrast voltage setting and return to the Calibration SELECT THE MODE screen. You may calibrate another mode, or press the **Back** button to return to the Biomed SELECT THE MODE screen.

View Calibration Data

This feature allows you to display the pump's calibration data onscreen. This screen is generally used in factory service or for trouble-shooting.

Select and open BIOMED from the main screen. Then, select CALIBRATION from the Biomed SELECT THE MODE screen. Select VIEW CALIBRATION from the Calibration SELECT THE MODE screen.


PRESS CONTINUE WHEN READY
FORCE 42 COUNTS 475 COUNTS 0
PLUNGER POS 151 COUNTS 901 COUNTS
PRESSURE 0 COUNTS 0 COUNTS
SYRINGE SIZE 125 COUNTS 975 COUNTS
CONTINUE

1. When ready, press the **Continue** button to return to the Calibration SELECT THE MODE screen. You may calibrate another mode, or press the **Back** button to Exit Biomed.

Save Changes and Exit

This feature is the normal path to save the new calibration values when exiting Biomed Calibration. If a mistake occurred in the calibration process use the **Back** button to exit from Biomed Calibration without saving any new calibration values.

1. Select SAVE CHANGES AND EXIT from Biomed Calibration SELECT THE MODE screen.

Exit Calibration without Saving Changes

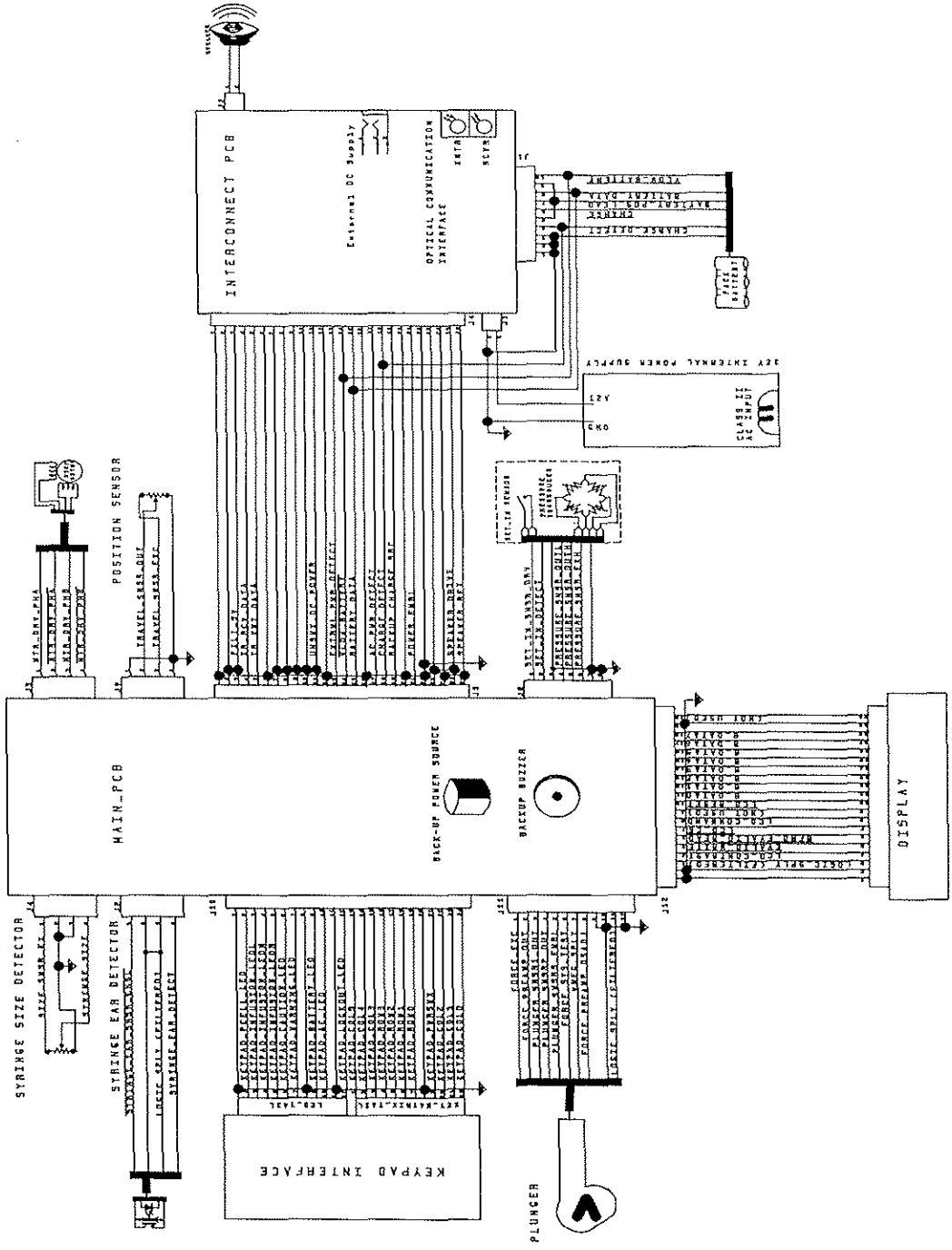
You may Exit CALIBRATION mode at any time – *without saving your changes* – by using the **Back** button.

To exit without saving changes, use the **Back** button to exit and the following screen appears.

1. Select YES to save calibration values and NO to exit without saving new calibration values.

PART 6: SCHEMATICS & PCB ASSEMBLIES

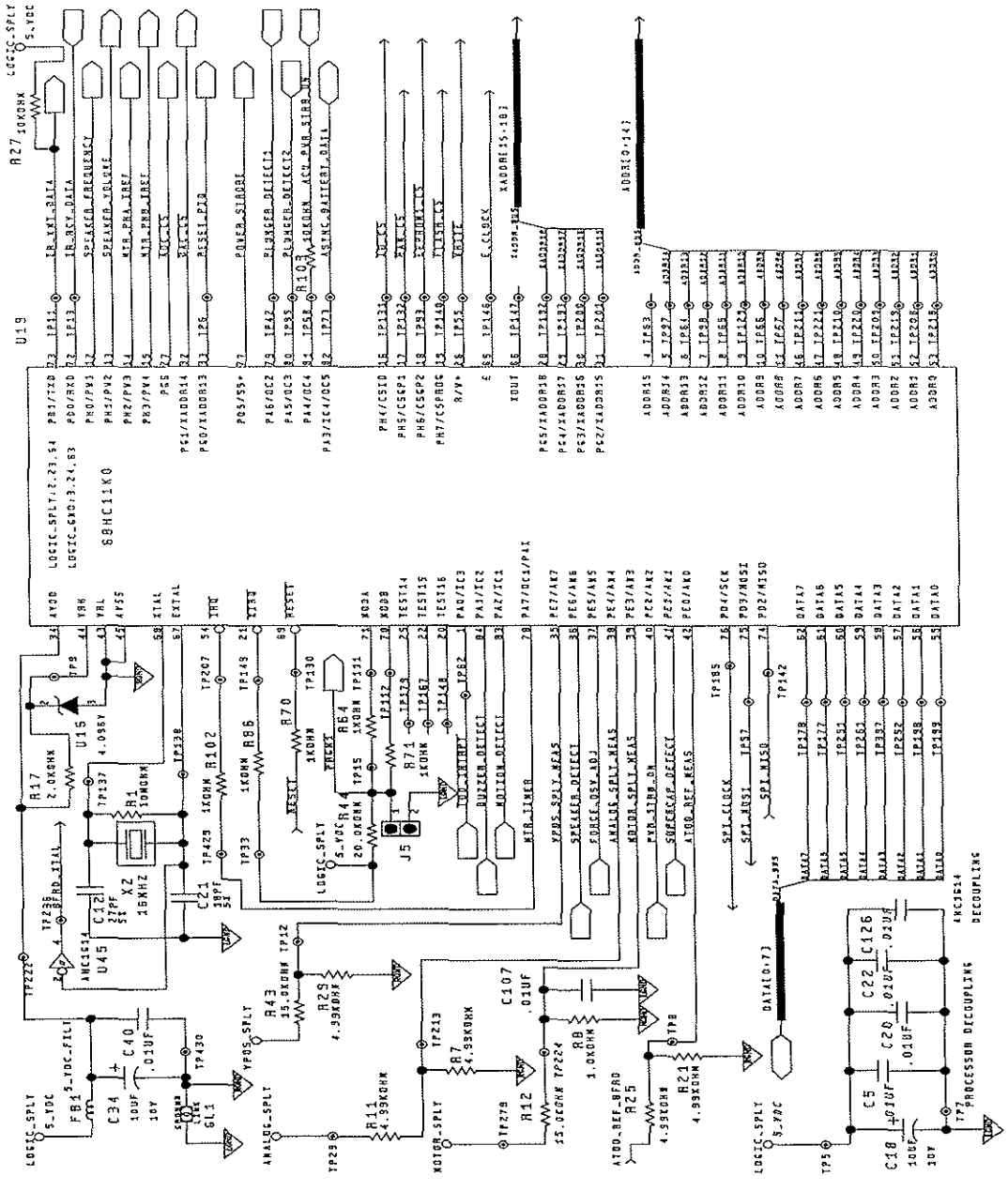
System Layout



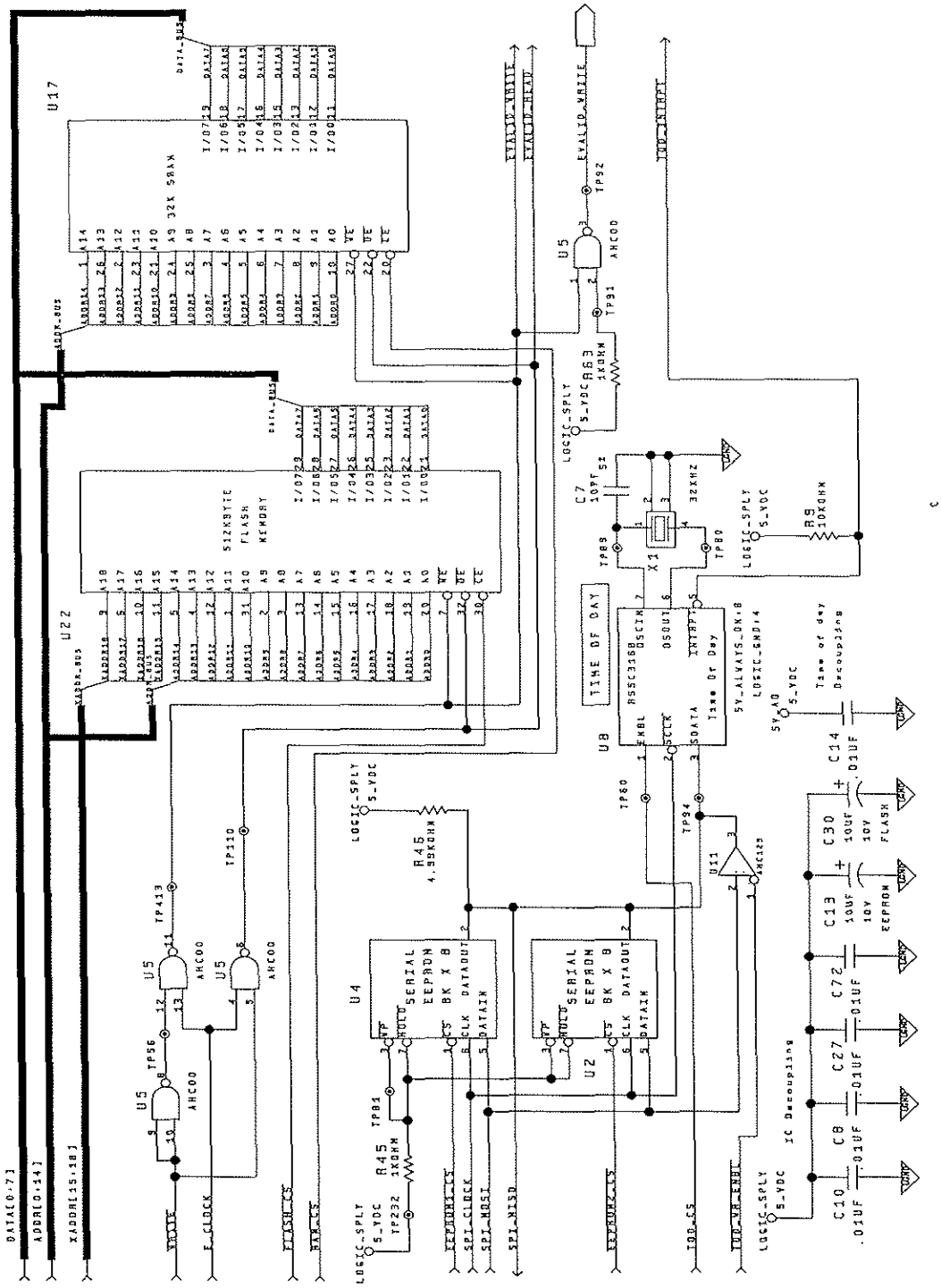
Main Board Schematics

The following are the *main board* schematics if the 3000 Series pump .

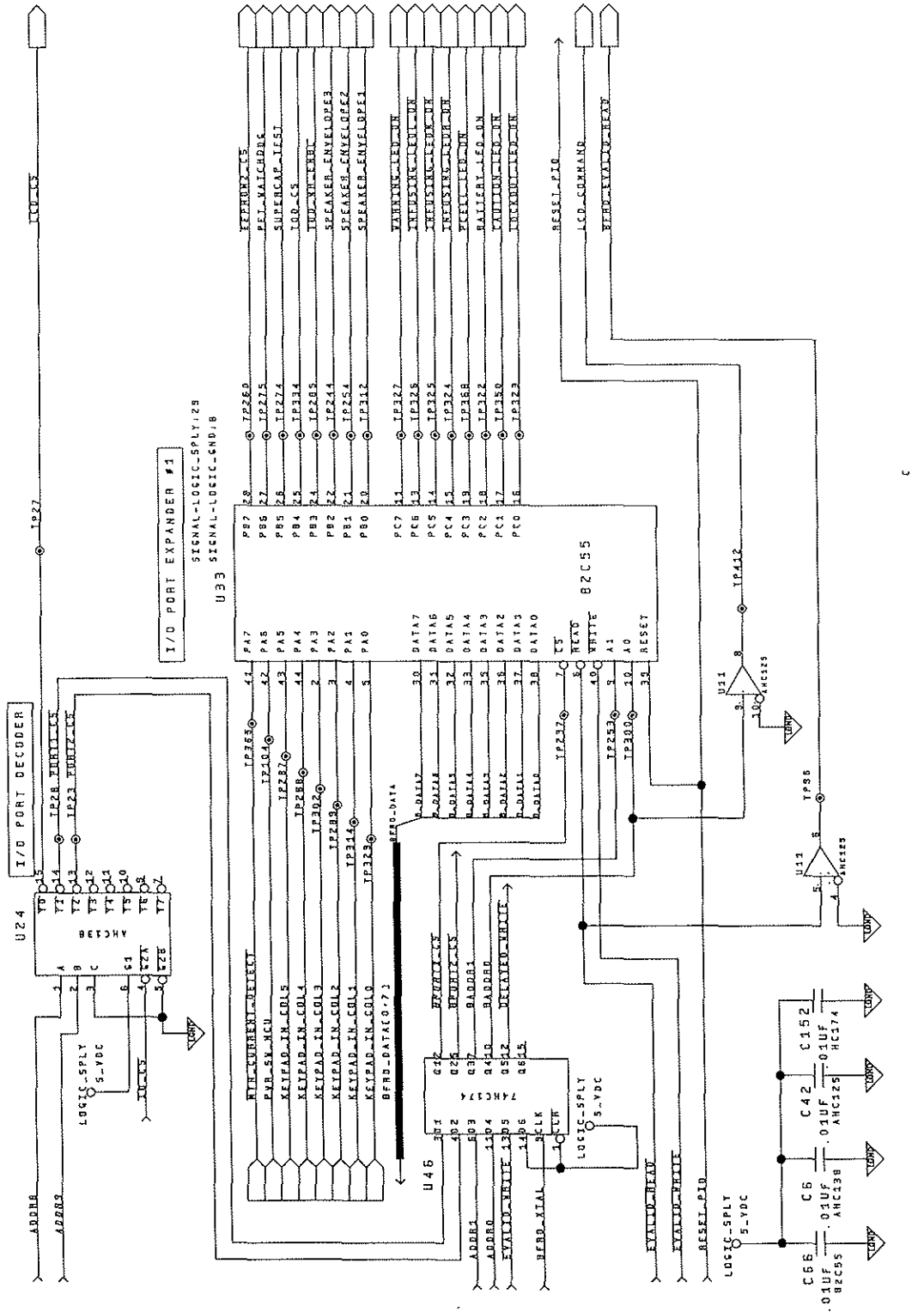
Main Board / Logic Kernel



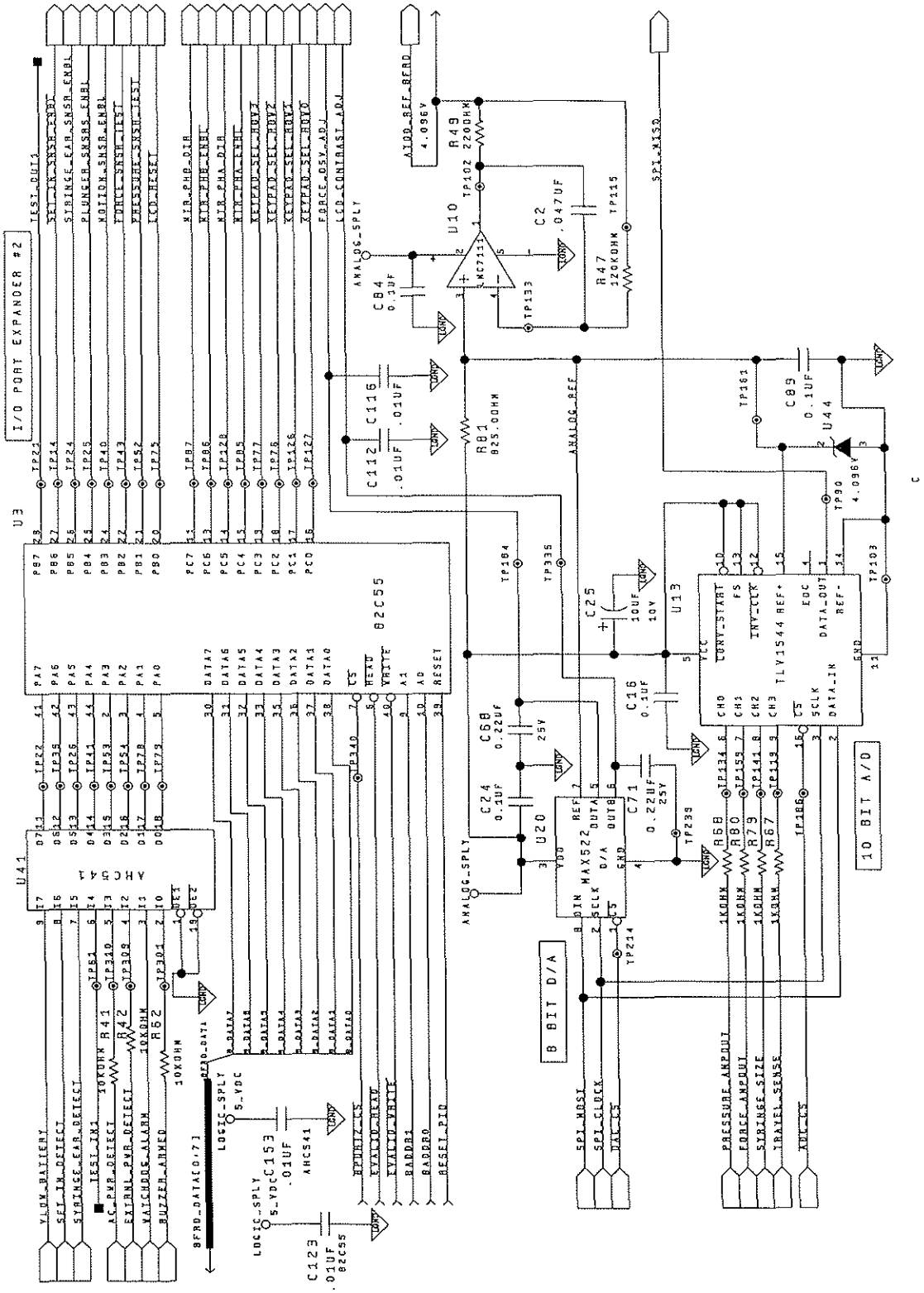
Main Board / Logic Kernel – Continued



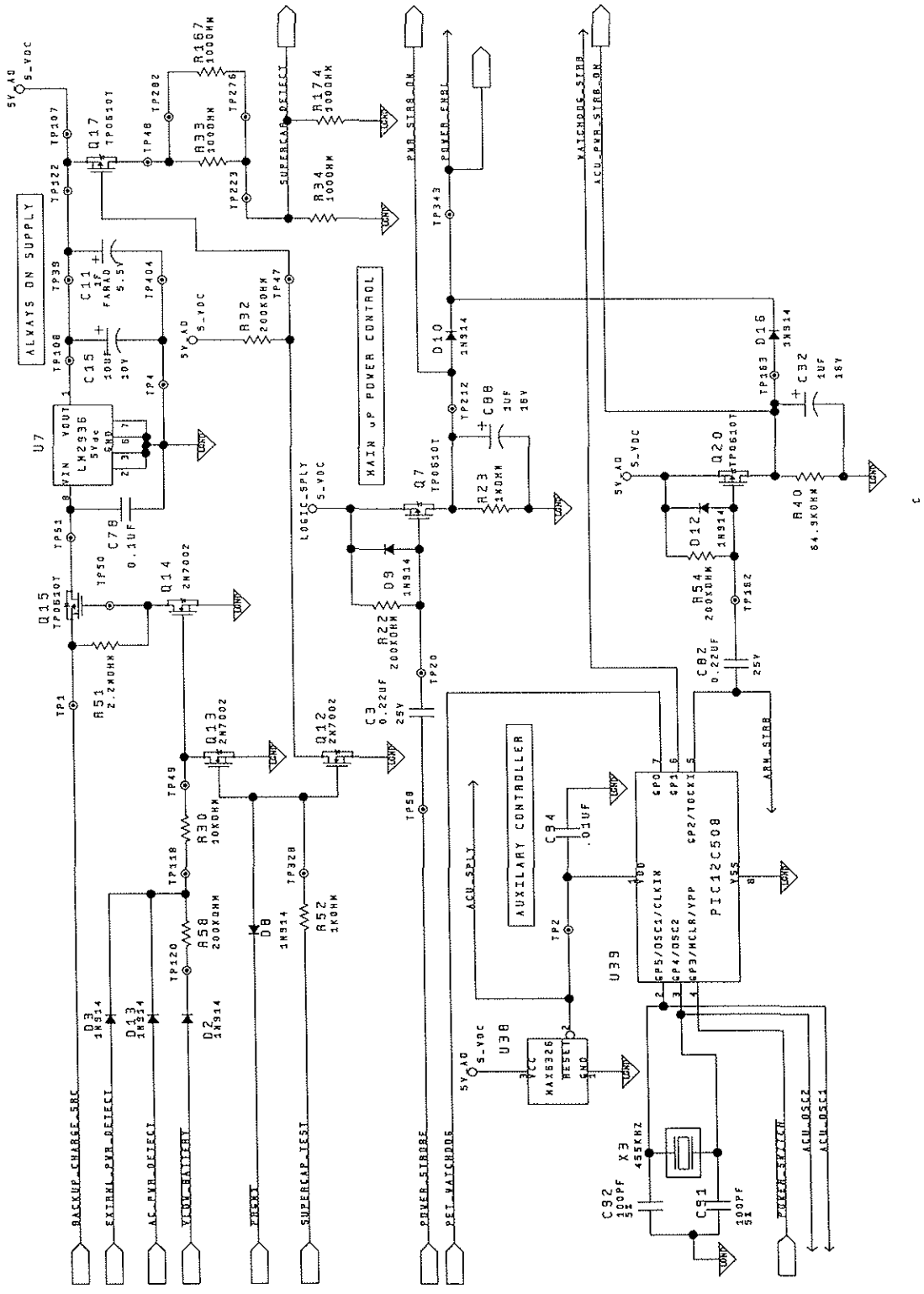
Main Board / Logic Kernel – Continued



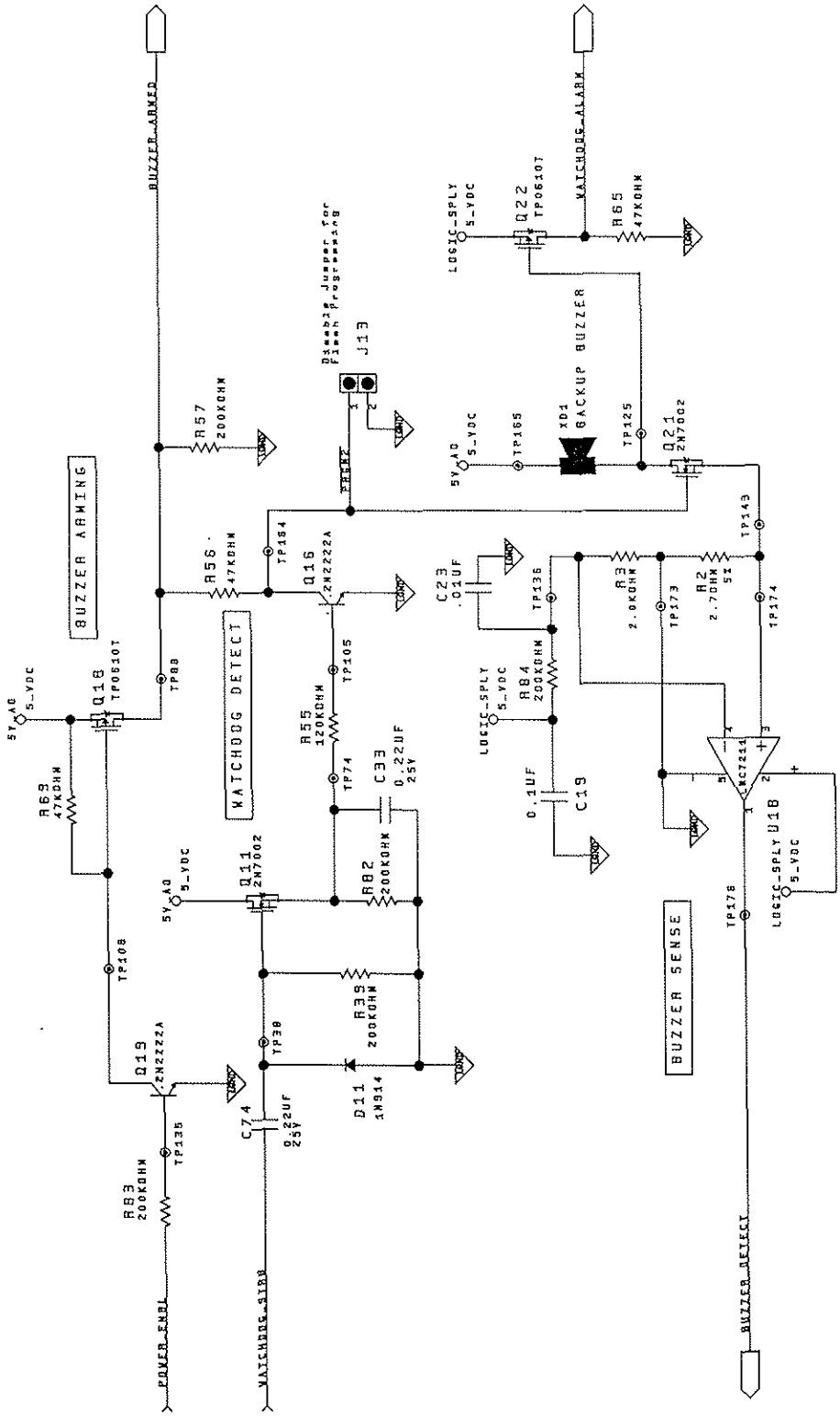
Main Board / Logic Kernel – Continued



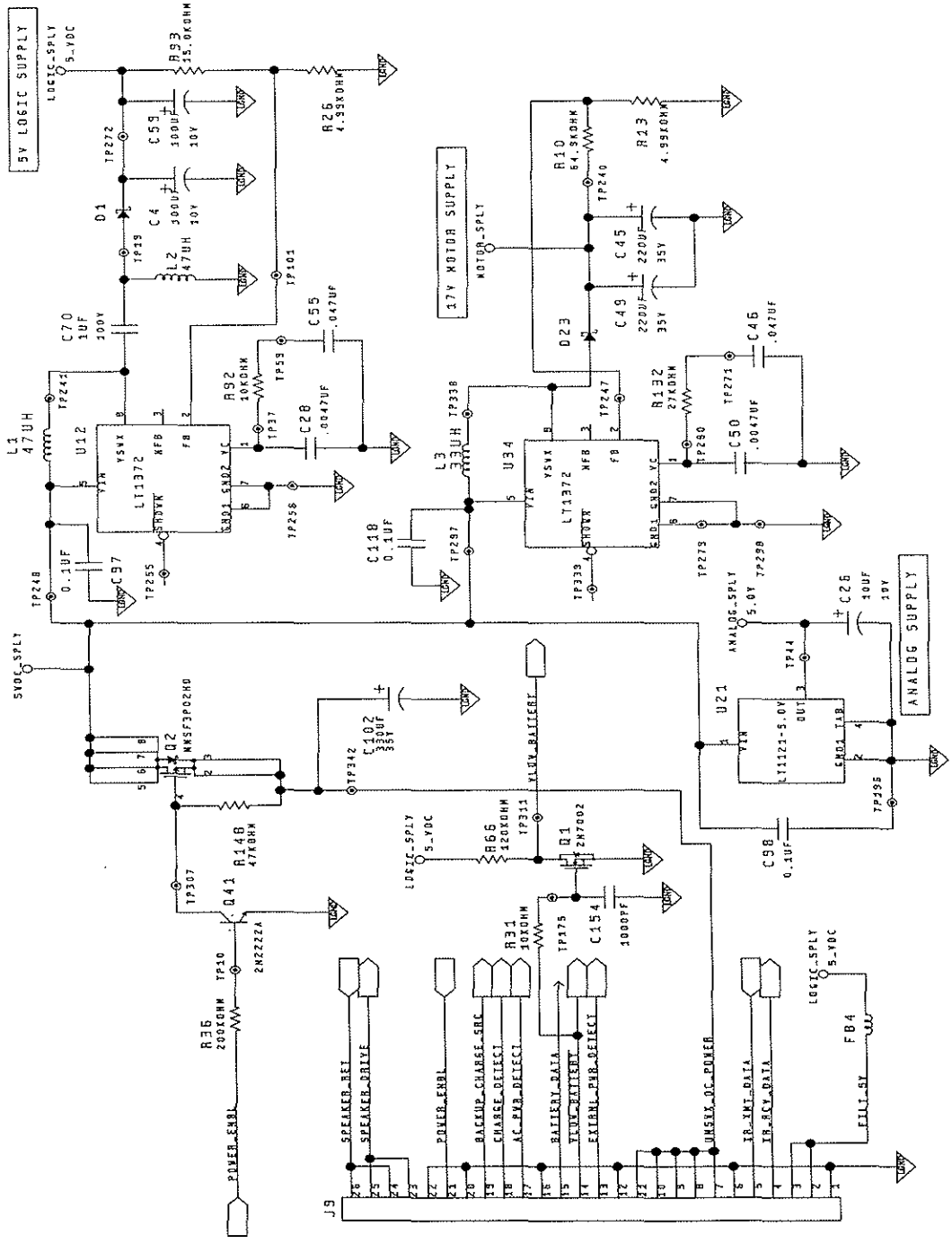
Main Board / Power Control Logic Core



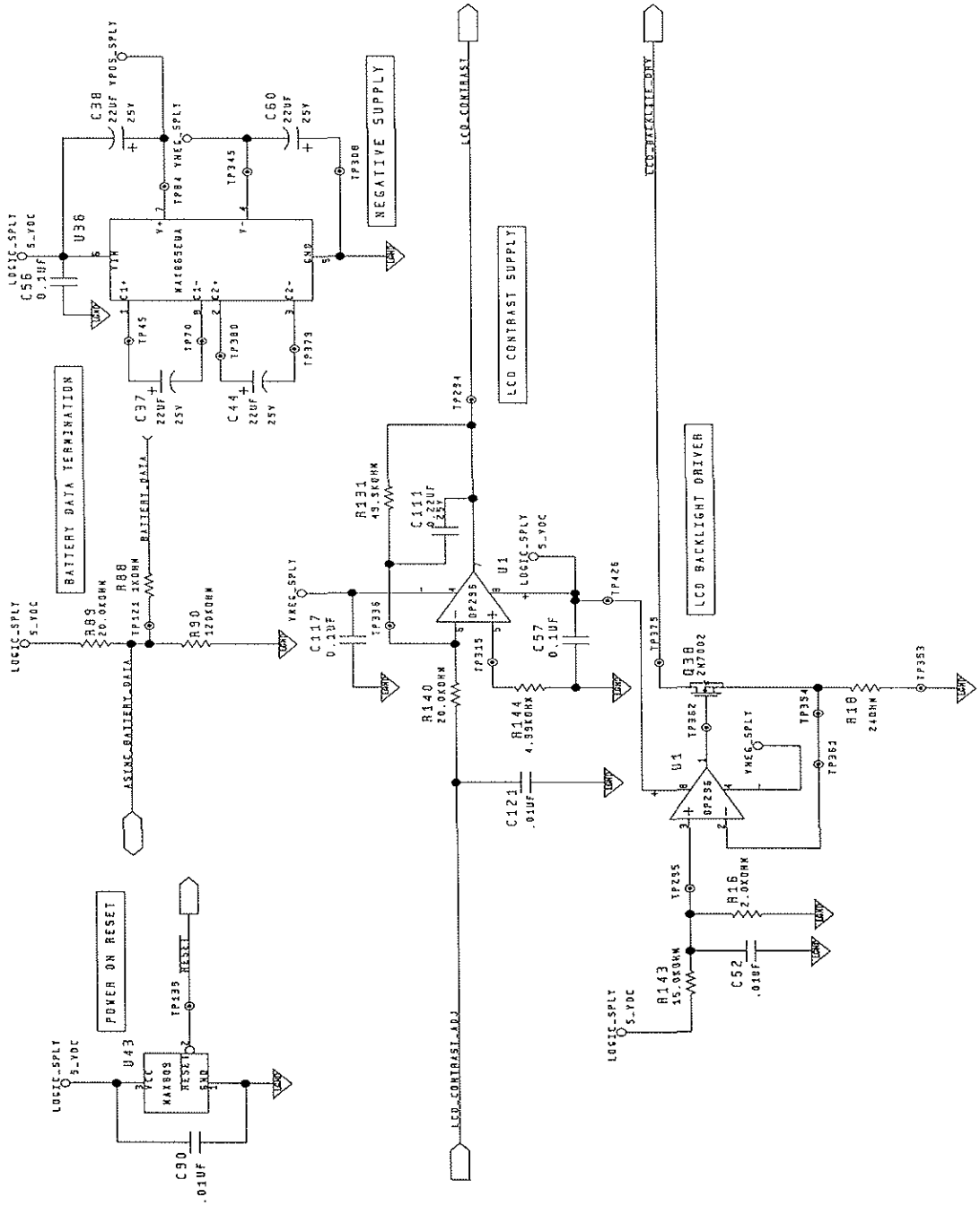
Main Board / Power Control Logic Core – Continued



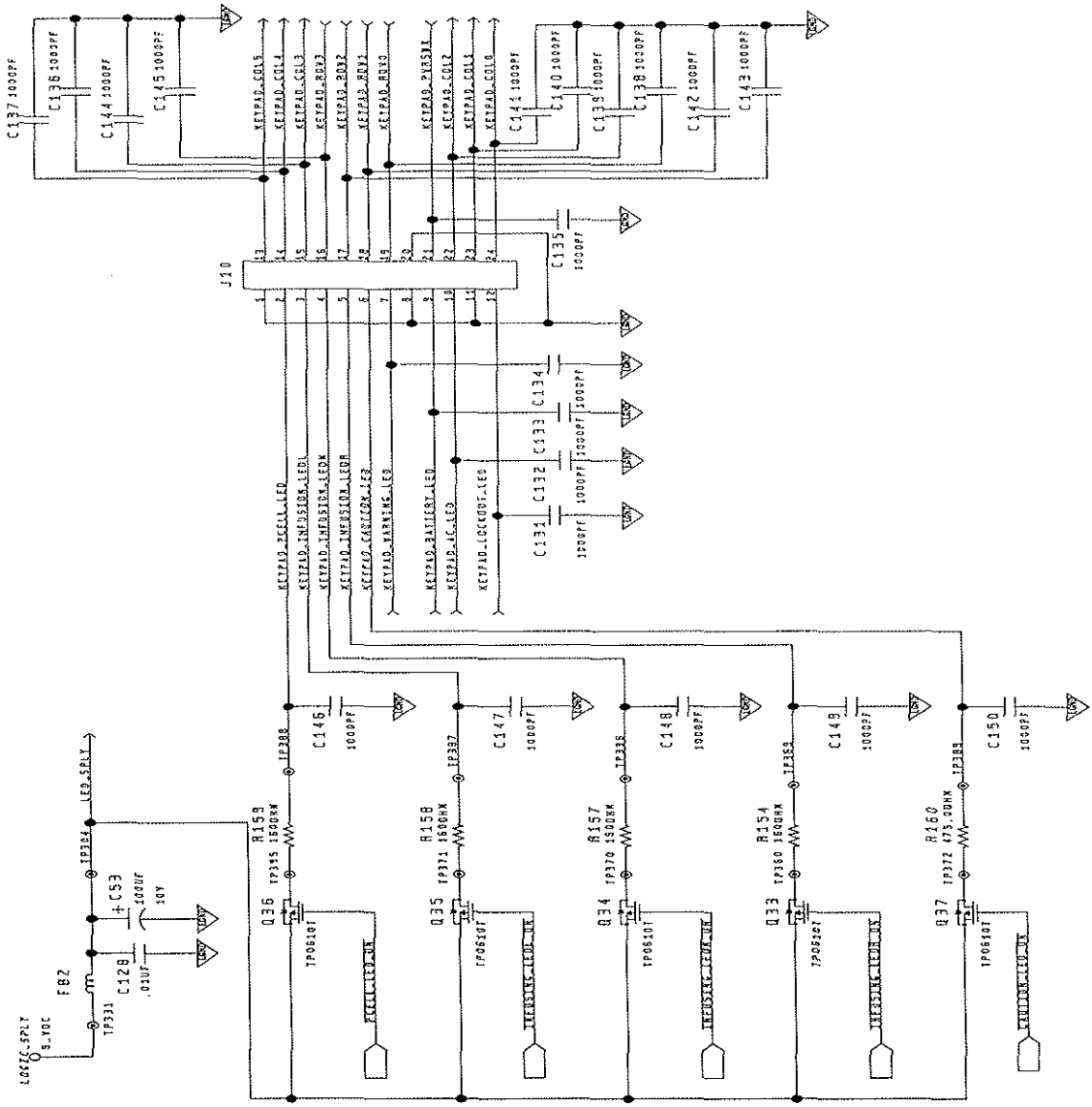
Main Board / DC-DC Converter



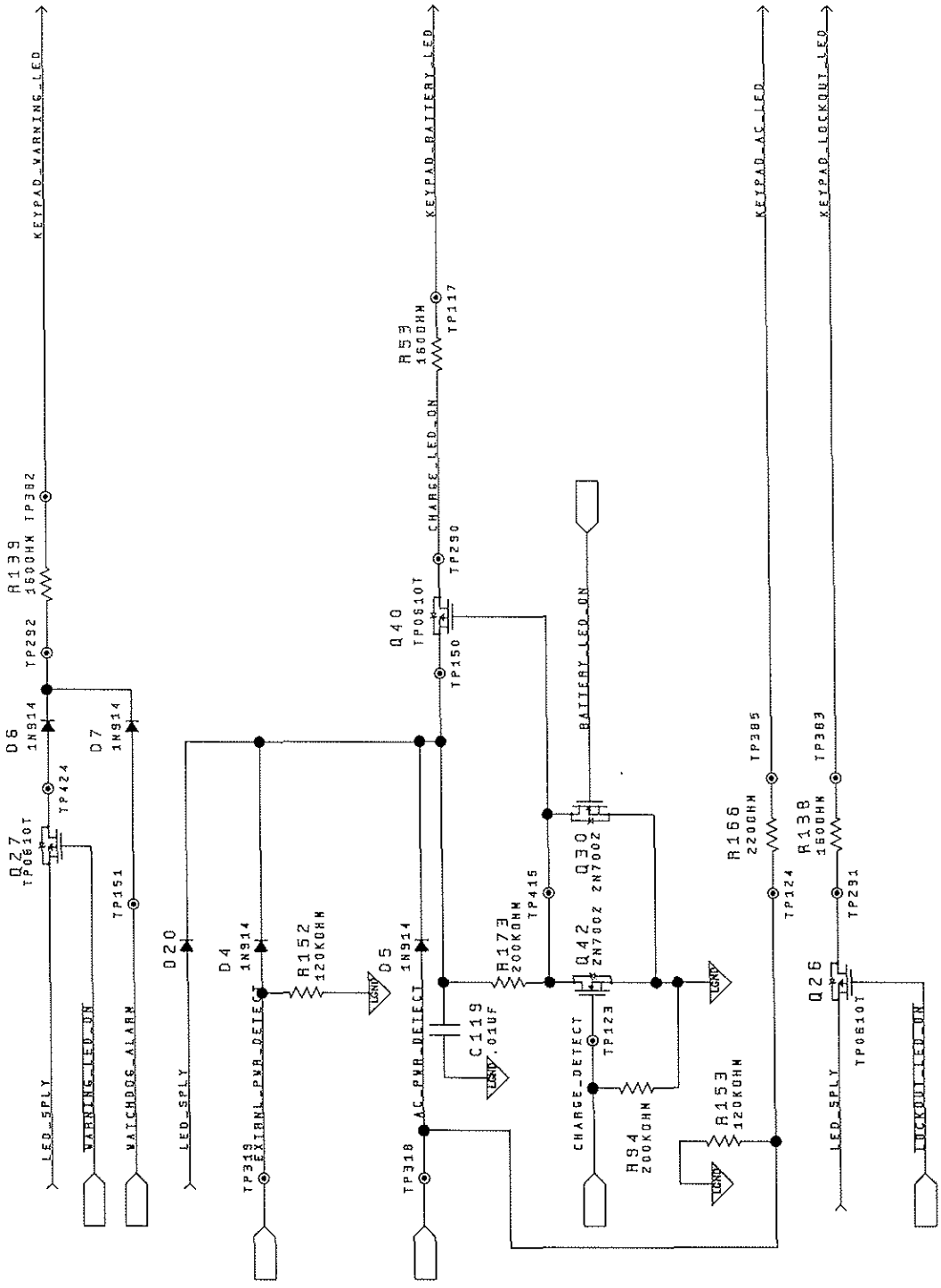
Main Board / DC-DC Converter – Continued



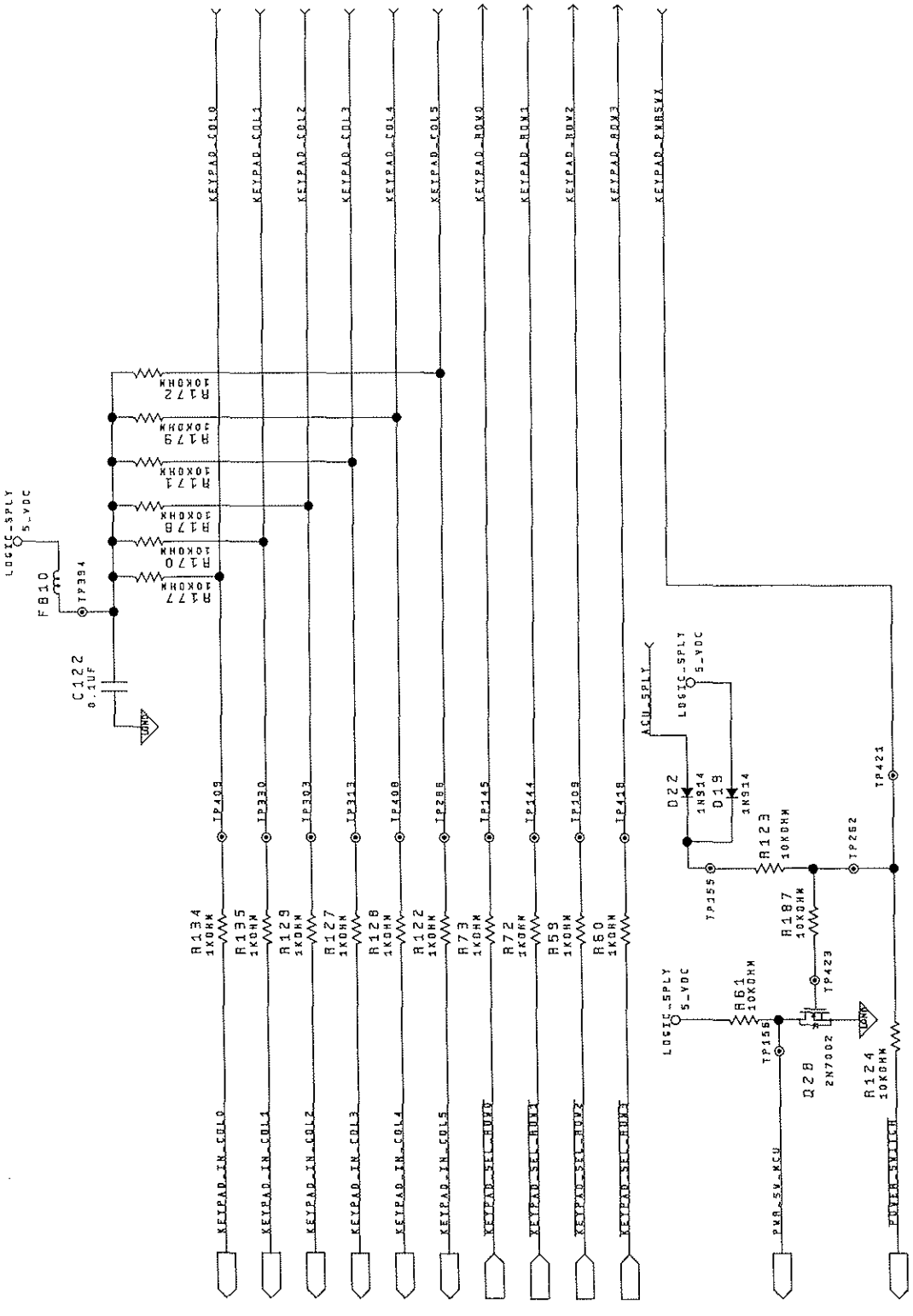
Main Board / Keypad Interface



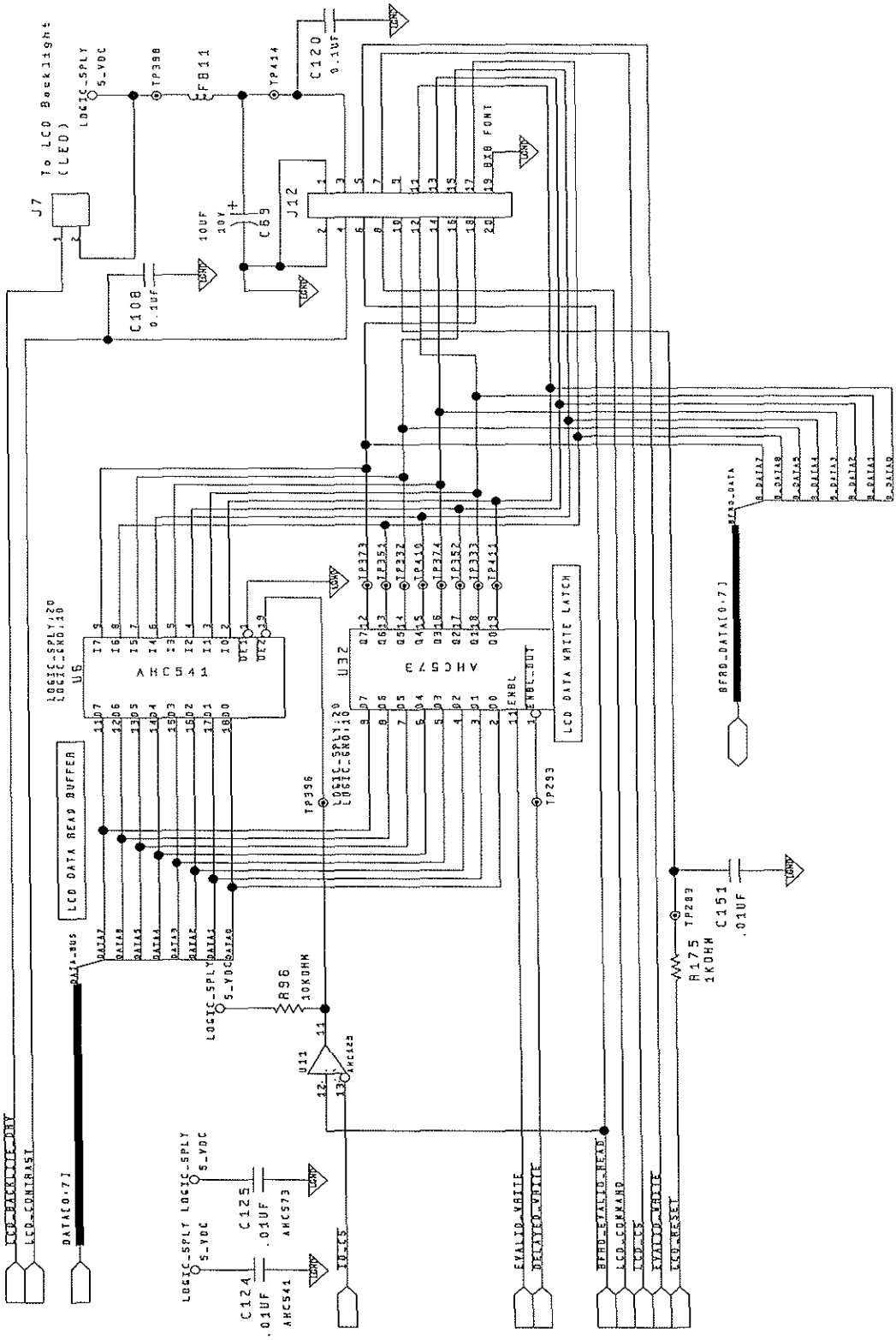
Main Board / Keypad Interface – Continued



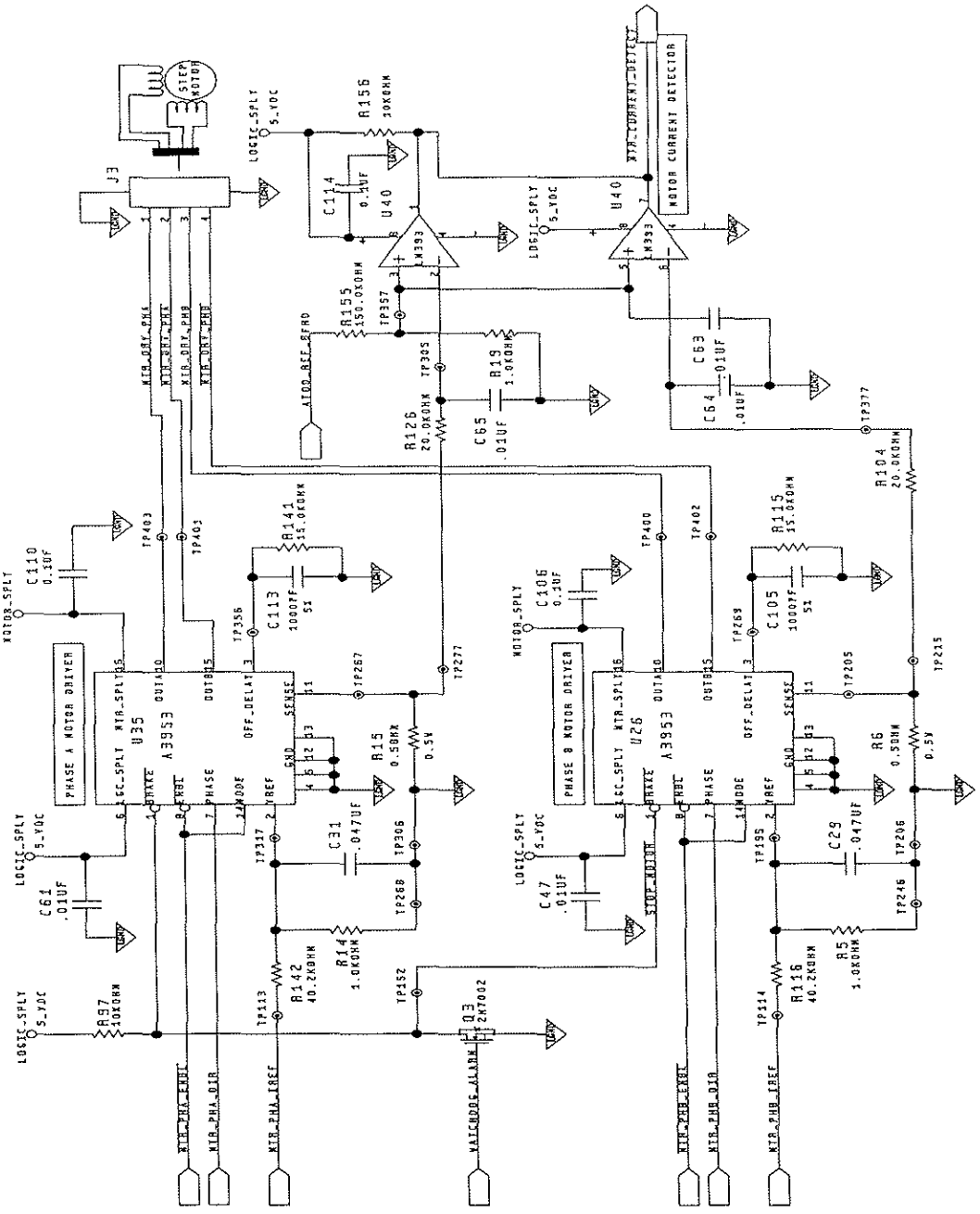
Main Board / Keypad Interface – Continued



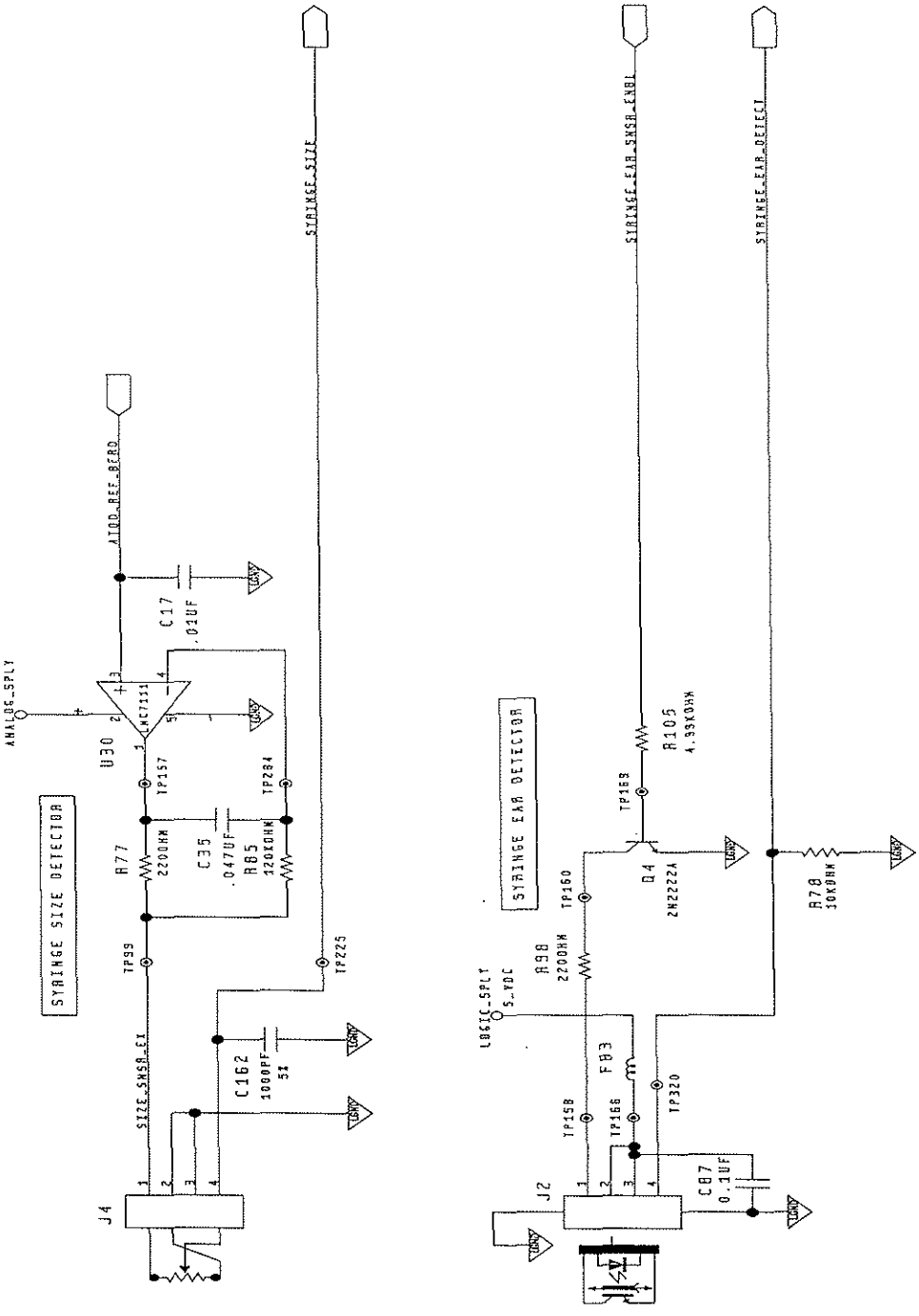
Main Board / Graphic Display Interface



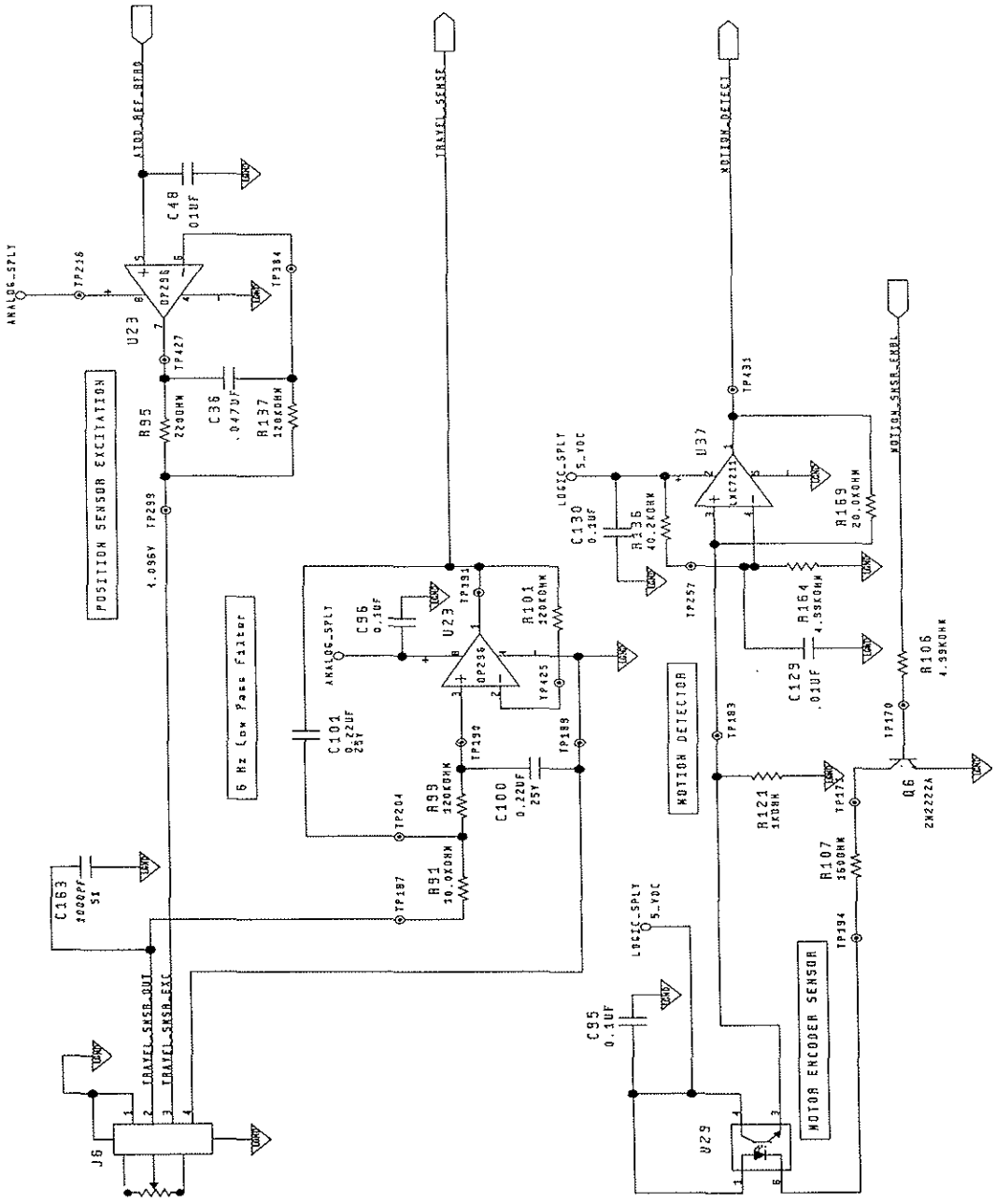
Main Board / Motor Drive



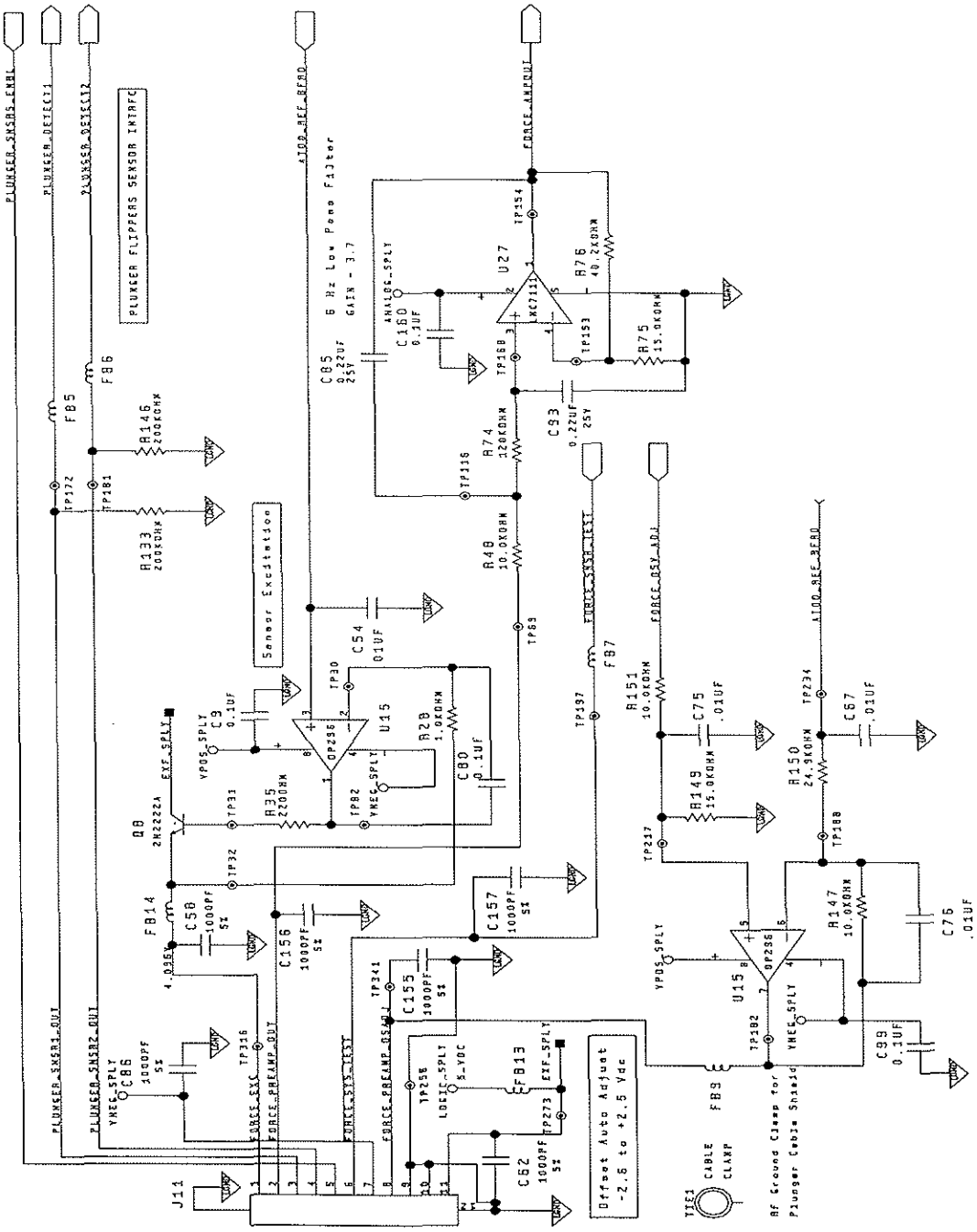
Main Board / Syringe Sensing



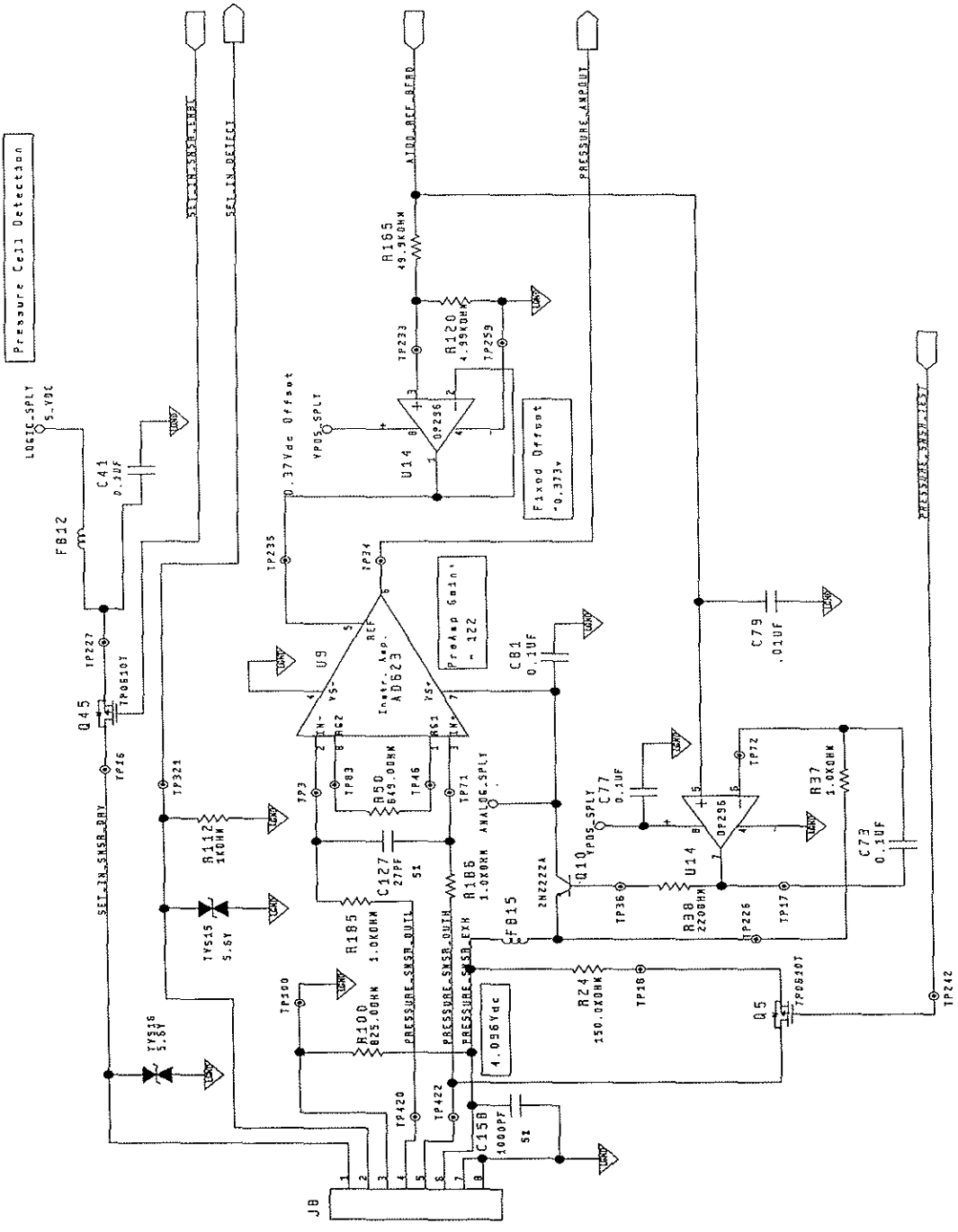
Main Board / Position Sensing



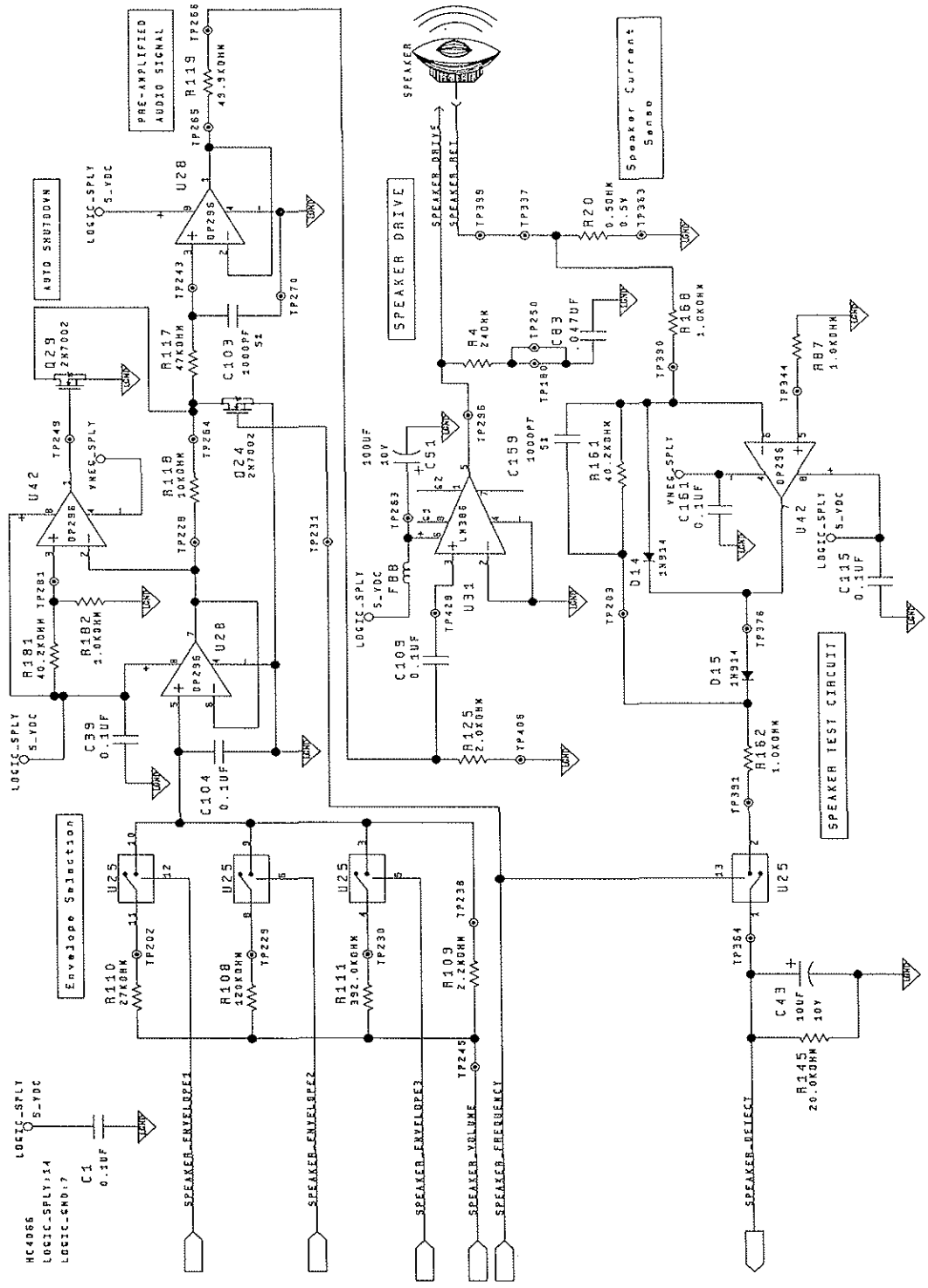
Main Board / Force Sensing



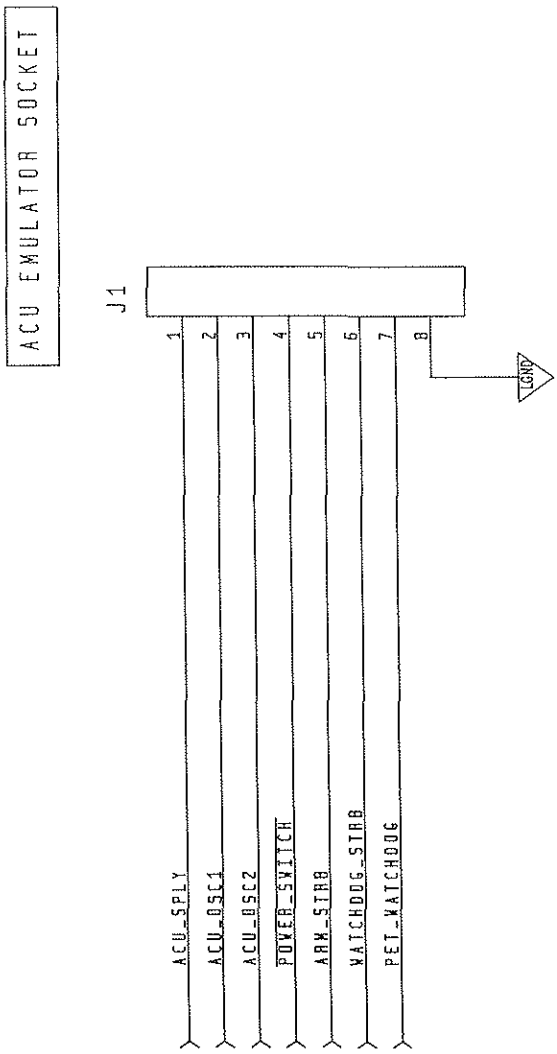
Main Board / Pressure Sensing



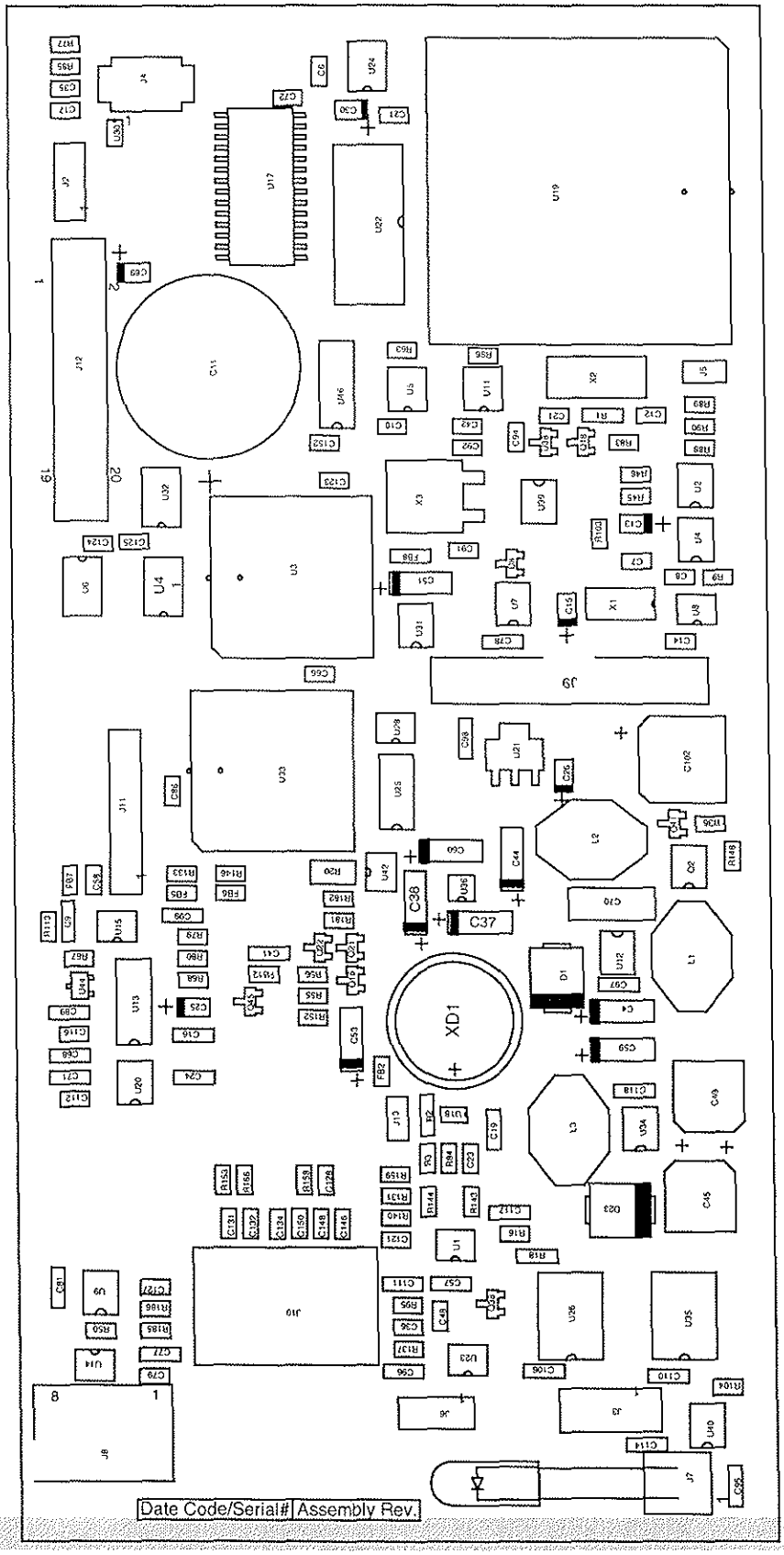
Main Board / Speaker Drive



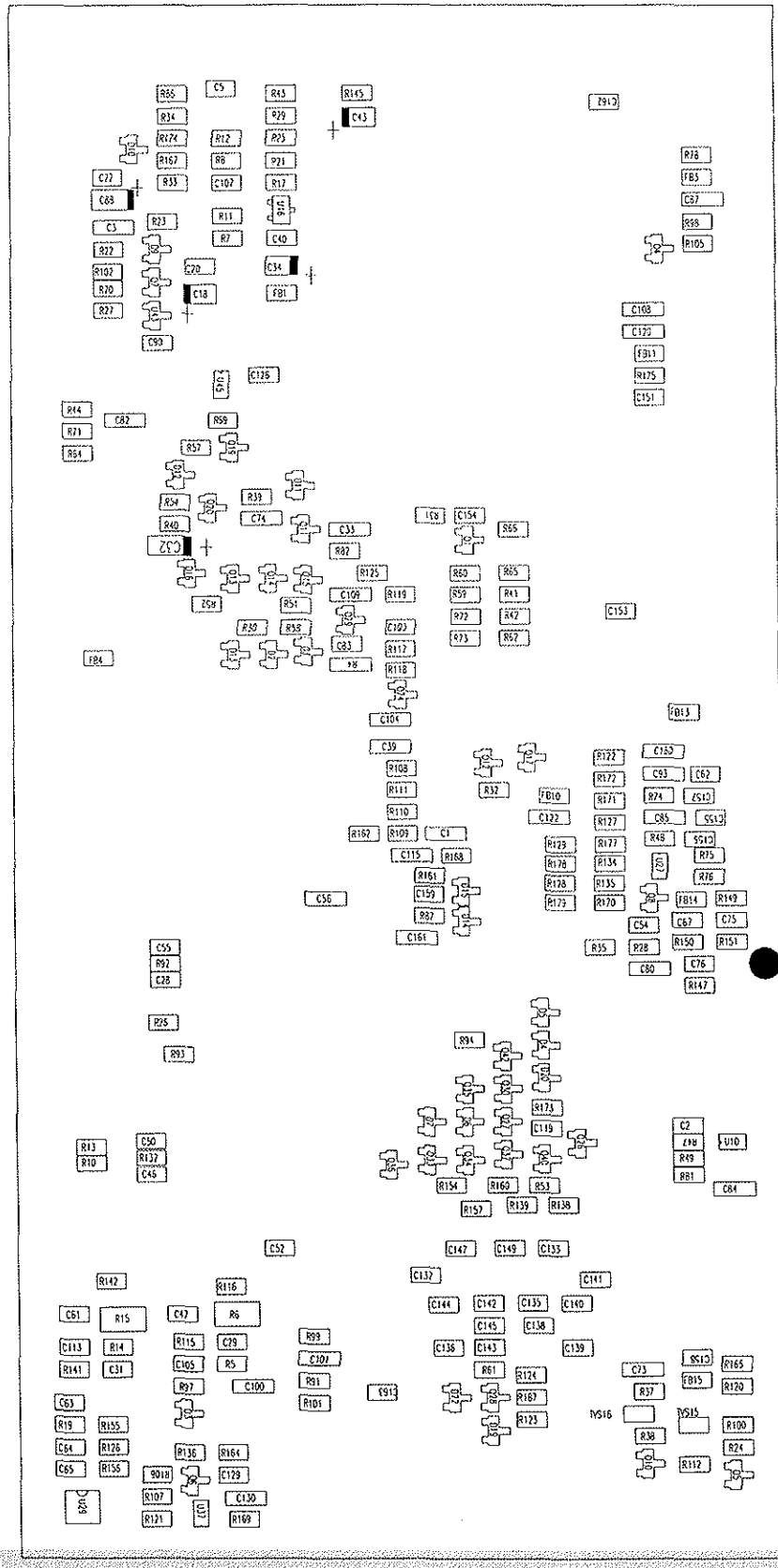
Main Board / ACU-ICE Socket



Main Board Assembly Drawing – Top Side



Main Board Assembly Drawing – Bottom Side



Main Board Assembly – Parts list

#	QTY	REF. DESIGNATOR	PACKAGE	VALUE	PART SPEC	MEDEX P/N
1	36	C1, C9, C16, C19, C24, C39, C41, C56, C57, C73, C77, C78, C80, C81, C84, C87, C89, C95, C96, C97, C98, C99, C104, C106, C108, C109, C110, C114, C115, C117, C118, C120, C122, C130, C160, C161	1206W	0.1UF	CAPACITOR, 50V, X7R, 10%, 1206; GMC31X7R104K50NT, CAL-CHIP 12065C104KAT2A AVX	6B10010400
2	8	C2, C29, C31, C35, C36, C46, C55, C83	0805W	.047UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R473K50NT, CAL-CHIP	6B20047300
3	11	C3, C33, C68, C71, C74, C82, C85, C93, C100, C101, C111	1206W	0.22UF	CAPACITOR, 25V, X7R, 10%, 1206; GMC31X7R224K25NE, CAL-CHIP 12063C224KAT2A AVX	6B10022400
4	2	C4, C59	TANT_D	100UF	CAPACITOR, 10V, TANT, 10%, SMT_D; TPSD107K010R0100, AVX; T495D107K010AS, KEMET	6B90010700
5	42	C5, C6, C8, C10, C14, C17, C20, C22, C23, C27, C40, C42, C47, C48, C52, C54, C61, C63, C64, C65, C66, C67, C72, C75, C76, C79, C90, C94, C107, C112, C116, C119, C121, C123, C124, C125, C126, C128, C129, C151, C152, C153	0805W	.01UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R103K50NT, CAL-CHIP	6B20010300
6	1	C7	0805W	10PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG100J50NT, CAL-CHIP	6B20010000
7	1	C11	SUPERCAP	1F	CAPACITOR, 5.5V, ELECT, 20%, RADIAL; FYD0H105Z; TOKIN	6140001F00
8	2	C12, C127	0805W	27PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG270J50NT, CAL-CHIP	6B20027000
9	9	C13, C15, C18, C25, C26, C30, C34, C43, C69	TANT_B	10UF	CAPACITOR, 10V, TANT, 20%, SMT_B; TCMIA106BT, CAL-CHIP; TAJB106M010R, AVX; T491B106M010AS, KEMET	6B90010600
10	1	C21	0805W	18PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG180J50NT, CAL-CHIP	G6000196
11	2	C28, C50	0805W	.0047UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R472K50NT, CAL-CHIP	6B20047200
12	2	C32, C88	TANT_A	1UF	CAPACITOR, 16V, TANT, 20%, SMT_A; TCMIC105AT, CAL-CHIP; TAJA105M016R, AVX	6B90010500
13	4	C37, C38, C44, C60	TANT_D	22UF	CAPACITOR, 25V, TANT, 10%, SMT_D; TPSD226M025R0200, AVX; T495D226M025AS, KEMET	6B90022600
14	2	C45, C49	SMT_8X10_8	220UF	CAPACITOR, 35V, ELECT, 20%, RADIAL; NACZ221M35V8X10.8TR13, NIC; 35VCV220GX, SURGE COMPONENTS	6B00022700
15	2	C51, C53	TANT_D	100UF	CAPACITOR, 10V, TANT, 20%, SMT_D; TCMIA107DT, CAL-CHIP; TAJD107M010R, AVX; T491D107M010AS, KEMET	6B900107B0

16	13	C58, C62, C86, C103, C105, C113, C155, C156, C157, C158, C159, C162, C163	0805W	1000PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG102J50NT, CAL-CHIP	6B20010200
17	1	C70	CAP_200MIL	1UF	CERAMIC, 100V, X7R, 10%, LEADED; SR401C105KAA, AVX; RPE114X7R105K100V, MURATA ERIE	G6000153
18	2	C91, C92	0805W	100PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG101J50NT, CALCHIP	6B20010100
19	1	C102	SMT_10X10_8	330UF	CAPACITOR, 35V, ELECT, 20%, RADIAL; NACZ331M35V10X10.8TRHIL, NIC	6B00033700
20	21	C131, C132, C133, C134, C135, C136, C137, C138, C139, C140, C141, C142, C143, C144, C145, C146, C147, C148, C149, C150, C154	0805W	1000PF	CAPACITOR, 50V, X7R, 10%, 0805;GMC21X7R102K50NT, CAL-CHIP	G6000245
21	2	D1,D23	SMC		CMSH3-60, CENTRAL SEMI; 30BQ060, INTERN. RECTIFIER	6D30000100
22	18	D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D19, D20, D22	SOT23		MMBD914LT1, MOTOROLA	6D20000100
23	13	FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB10, FB11, FB12, FB13, FB14, FB15	0805W		BLM21A102SPT, MURATA ERIE	6FB0000100
24	1	FB8	1206W		BLM31P500SPT, MURATA ERIE	6FB0000200
25	1	GLJ	GNDLNK		N/A	N/A
26	2	J2,J6	4P_059SMTHDR		B4B-ZR-SM3-TF, JST	G6000147
27	1	J3	4P_079SMTHDR		B4B-PH-SM3-TB, JST	6280000200
28	1	J4	4P_050THHDR		104071-7, AMP	G6000148
29	2	J5,J13	2P_THJMPR		HTSW-102-06-T-S, SAMTEC	G6000178
30	1	J7	2PINTH_TERMBLK		30.870.002 OR 930-T-DS-02, WECO	6280000500
31	1	J8	8P_050RATHHDR		53048-0810 molex	G6000584
32	1	J9	26P_079THDRHDR		1306-26-S-02, SINGATRON	G6000241
33	1	J10	24P_050RATHDRHDR		1-104069-2, AMP	G6000150
34	1	J11	11P_059SMTHDR		B11B-ZR-SM3-TF, JST	G6000146
35	1	J12	20P_100THHDR		609-2027, THOMAS & BETTS	6280000800
36	2	L1, L2	SMT_POT CORE	47UH	DT3316P-473, COILCRAFT	G6000151
37	1	L3	SMT_POT CORE	33UH	DT3316P-333, COILCRAFT	G6000152
38	13	Q1, Q3, Q11, Q12, Q13, Q14, Q21, Q24, Q28, Q29, Q30, Q38, Q42	SOT23		2N7002T1, SILICONIX (TEMIC); CENTRAL SEMICONDUCTOR	6Q10000100
39	1	Q2	SO8		MMSF3P02HD,MOTOROLA; SI9430DY,SILICONIX (TEMIC)	6Q00000200
40	7	Q4, Q6, Q8, Q10, Q16, Q19, Q41	SOT23		MMBT2222ALT1, MOTOROLA	6Q10000300
41	16	Q5, Q7, Q15, Q17, Q18, Q20, Q22, Q26, Q27, Q33,	SOT23		TP0610T, SILICONIX (TEMIC); CENTRAL SEMICONDUCTOR	6Q10000200

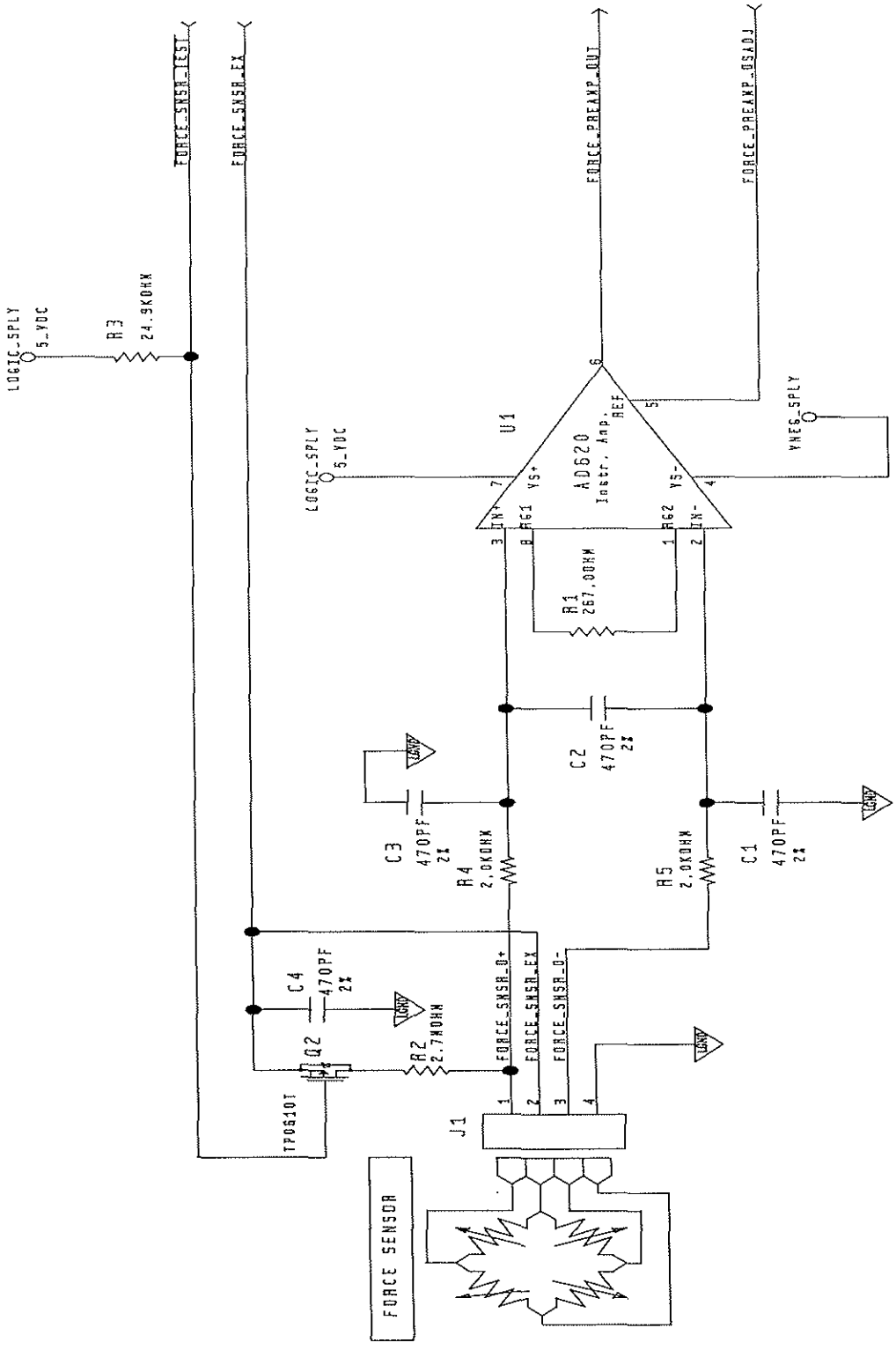
		Q34, Q35, Q36, Q37, Q40, Q45				
42	1	R1	1206W	10MOHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J106CT, CAL-CHIP	6A10010600
43	1	R2	1206W	2.7OHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J2R7CT, CAL-CHIP; IRC WCR1206	6A1002R700
44	4	R3, R16, R17, R125	0805W	2.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2001CT, CAL-CHIP	G6000154
45	2	R4, R18	1206W	24OHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J240CT, CAL-CHIP; ERJ-8GEYJ240V, PANASONIC	6A10024000
46	12	R5, R8, R14, R19, R28, R37, R87, R162, R168, R182, R185, R186	0805W	1.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1001CT, CAL-CHIP	6A20100100
47	3	R6, R15, R20	2010	0.5OHM	RESISTOR, 1/2W, TCR=100PPM, 1%, 2010; WSL2010R500F, DALE; LR201001R500F, IRC	6A0000R500
48	13	R7, R11, R13, R21, R25, R26, R29, R46, R105, R106, R120, R144,R164	0805W	4.99KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4991CT, CAL-CHIP	6A20499100
49	24	R9, R27, R30, R31, R41, R42, R61, R62, R78, R92, R96, R97, R103, R118, R123, R124, R156, R170, R171, R172, R177, R178, R179, R187	0805W	10KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J103CT, CAL-CHIP	6A20010300
50	2	R10, R40	0805W	64.9KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F6492CT, CAL-CHIP	6A20649200
51	8	R12, R43, R75, R93, R115, R141, R143, R149	0805W	15.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1502CT, CAL-CHIP	6A20150200
52	14	R22, R32, R36, R39, R54, R57, R58, R82, R83, R84, R94, R133, R146, R173	0805W	200KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J204CT, CAL-CHIP	6A20020400
53	1	R23	0805W	1MOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J105CT, CAL-CHIP	6A20010500
54	2	R24, R155	0805W	150.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1503CT, CAL-CHIP	6A20150300
55	4	R33, R34, R167, R174	0805W	100OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J101CT, CAL-CHIP	6A20010100
56	7	R35, R38, R49, R77, R95, R98, R166	0805W	220OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J221CT, CAL-CHIP	6A20022100
57	7	R44, R89, R104, R126, R140, R145,R169	0805W	20.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2002CT, CAL-CHIP	6A20200200
58	26	R45, R52, R59, R60, R63, R64, R67, R68, R70, R71, R72, R73, R79, R80, R86, R88, R102, R112, R121, R122, R127, R128, R129, R134, R135, R175	0805W	1KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J102CT, CAL-CHIP	6A20010200
59	12	R47, R55, R66, R74, R85, R90, R99, R101, R108, R137, R152, R153	0805W	120KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J124CT, CAL-CHIP	6A20012400
60	4	R48, R91, R147, R151	0805W	10.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1002CT, CAL-CHIP	6A20100200

61	1	R50	0805W	649.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F6490CT, CAL-CHIP	G6000258
62	2	R51, R109	0805W	2.2MOHM	RESISTOR, 1/10W, TCR=400PPM, 5%, 0805; RM10J225CT, CAL-CHIP	6A20022500
63	8	R53, R107, R138, R139, R154, R157, R158, R159	0805W	160OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J161CT, CAL-CHIP	6A20016100
64	5	R56, R65, R69, R117, R148	0805W	47KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J473CT, CAL-CHIP	6A20047300
65	6	R76, R116, R142, R161, R181, R136	0805W	40.2KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4022CT, CAL-CHIP	6A20402200
66	2	R81, R100	0805W	825.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F8250CT, CAL-CHIP	6A20825000
67	2	R110, R132	0805W	27KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J273CT, CAL-CHIP	6A20027300
68	1	R111	0805W	392.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F3923CT, CAL-CHIP	6A20392300
69	1	R113	0805W	51OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J510CT, CAL-CHIP	G6000351
70	3	R119, R131, R165	0805W	49.9KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4992CT, CAL-CHIP	6A20499200
71	1	R150	0805W	24.9KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2492CT, CAL-CHIP	G6000156
72	1	R160	0805W	475.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4750CT, CAL-CHIP	G6000155
73	412	TP1, TP2, TP3, TP4, TP5,	TESTPOINT			N/A
74	2	TVS15, TVS16	0805W		VC080505A150, AVX	6TS0000100
75	5	U1, U14, U23, U28, U42	TSSOP8		OP296HRU, ANALOG DEVICES;	6U00000500
76	2	U2, U4	SO8		AT25128N-10SC AT25128N-10SI Atmel	G6000382
77	2	U3, U33	44PLCC		CS82C55A, HARRIS/INTERSIL; CA82C55A-8CN, TUNDRA	6U10000100
78	1	U5	TSSOP14		SN74AHC00PWR, TEXAS INSTR;	6U10000300
79	2	U6, U41	TSSOP20		SN74AHC541PWR, TEXAS INSTR;	6U10000400
80	1	U7	SO8		LM2936M-5.0; NATIONAL SEMI	6U00000300
81	1	U8	SSOP8		RS5C316B, RICOH	6U10000500
82	1	U9	SO8		AD623AR, ANALOG DEVICES	6U00000200
83	3	U10, U27, U30	SOT23-5		LMC7111BIM5, NATIONAL SEMICONDUCTOR; MIC7111BM5, MICREL	6U00000100
84	1	U11	TSSOP14		SN74ACH125PWR, TEXAS INSTR.	G6000160
85	2	U12, U34	SO8		LT1372CS8, LINEAR TECH	6U00000400
86	1	U13	SO16		TLV1544CD, TEXAS INSTR.	6U10000600
87	1	U16	TO236AB		LM4040DIM3-4.1, NATIONAL SEMICONDUCTOR, MICREL SEMICONDUCTOR	G6000163
88	1	U17	SOP28		TC55257DFL85L, TOSHIBA; TC55257DFL70L, TOSHIBA; M5M5256DFP-70LL; MITSUBISHI LH52256CN-70LL; SHARP	6U10000701

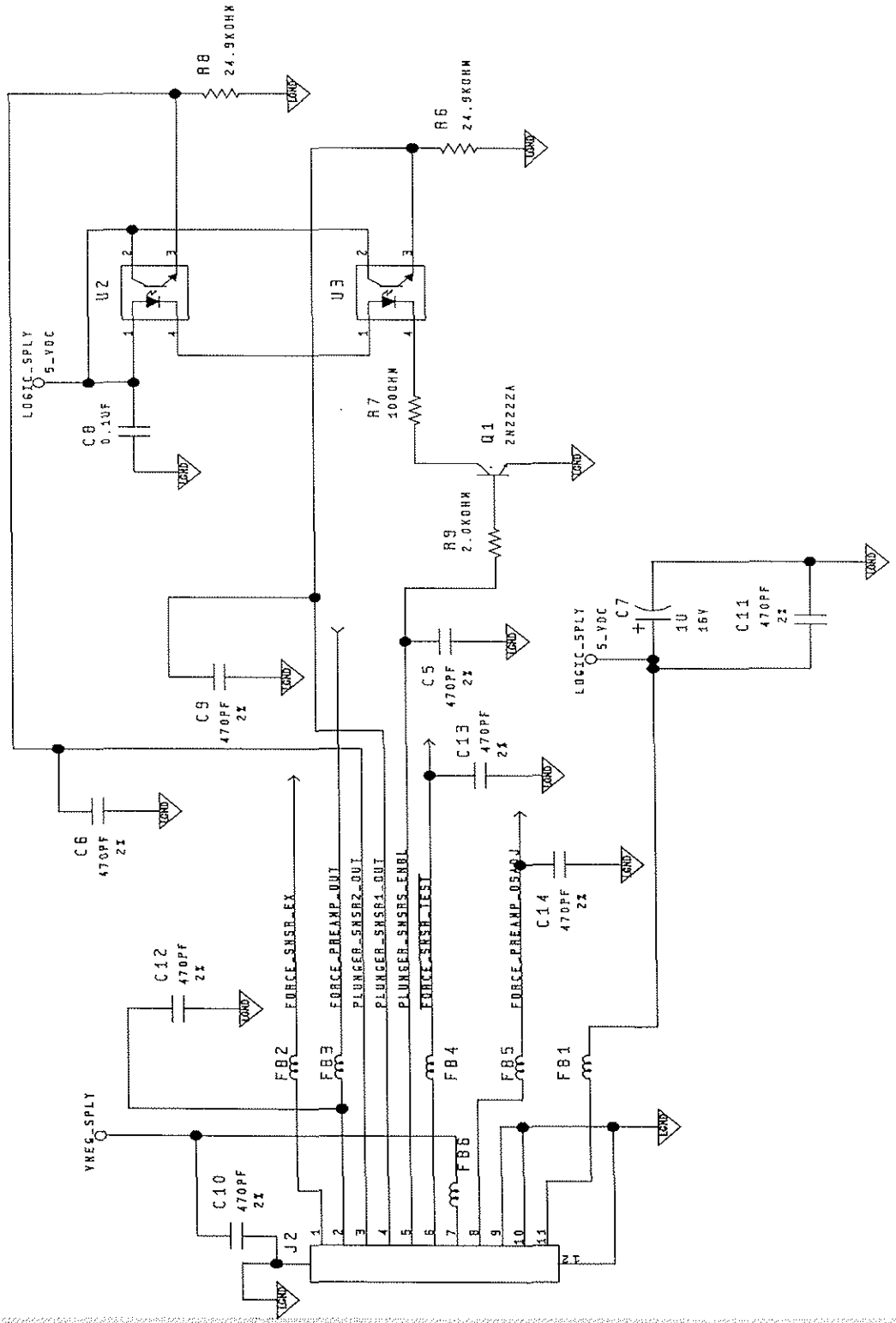
89	2	U18, U37	SOT23-5		LMC7211AIM5, NATIONAL SEMICONDUCTOR; MIC7211BM5, MICREL	6U00000600
90	1	U19	84PLCC_SKT		68HC11K1CFN4 OR 68HC11K0CFN4, MOTOROLA	G6000279
91	1	U20	SO8		MAX522CSA, MAXIM	6U10000900
92	1	U21	SOT223		LT1121CST-5, LINEAR TECH	6U00000700
93	1	U22	32TSOP		AT29C040A12TC, ATMEL;	6U10001001
94	1	U24	TSSOP16		SN74AHC138PWR, TEXAS INSTR.	6U10001100
95	1	U25	SO14		MC74HC4066D, MOTOROLA; SN74HC4066D, TEXAS INSTR.	6U10001200
96	2	U26, U35	SO16W		A3953SLB, ALLEGRO	6U00000800
97	1	U29	SO6		SFH9201, SIEMENS	G6000157
98	1	U31	SO8		LM386M-1, NATIONAL SEMICONDUCTOR; NJM386BM, NEW JAPAN RADIO	6U00001000
99	1	U32	TSSOP20		SN74AHC573PWR, TEXAS INSTR;	6U10001400
100	1	U36	SSO8		MAX865EUA, MAXIM	6U00001100
101	1	U38	SOT23		MAX6326UR31-T, MAXIM	G6000161
102	1	U39 or	SO8W or		PIC12C50804/SM, MICROCHIP (progr'd)	G6000407
103	1	U40	SO8		LM393M, NATIONAL SEMI; LM393D, TEXAS INSTRUMENTS	6U00001300
104	1	U43	SOT23		MAX809LEURT, MAXIM; ADM809LART, ANALOG DEVICES	6U00000900
105	1	U44	TO236AB		LM4040BIM3-4.1, NATIONAL SEMI	6U00001400
106	1	U45	SOT23-5		SN74AHC1G14DBVR, TEXAS INSTRUMENTS	G6000197
107	1	U46	SO16		MC74HC174AD, MOTOROLA; SN74HC174D, TEXAS INSTR.; 74HC174D, PHILIPS; M74HC174M1R, SGS	G6000198
108	1	X1	SMT_32KHZX TAL	32KHZ	MC306-32.768KA-E3, EPSON; ECPSM29T-32.768KTR, ECLIPTEK; SX1555-32.768KT/R, MTRON	68032KHZ00
109	1	X2	SMT_16MHZ XTAL	16MHZ	EC2SM 16.000MHZ T&R, ECLIPTEK;	G6000281
110	1	X3	SMT_430KHZ XTAL	455KHZ	CSBF455J840TC01, MURATA ERIE;	680455KZ00
111	1	XD1	TH_BUZZER		HMB-06, STAR MICRONIX	6940000100
112	1	PCB	N/A		RAW, PRINTED CIRCUIT BOARD	G6000242
113	1	PRESS_IN NUT	N/A		PRESS-IN NUT , 2-56 THREAD, 0.219" DIA., STAINLESS STEEL; P/N 4860, KEYSTONE; KFS2-256, PEM	G6000256
114	1	U15	TSSOP8		OP27ARU; ANALOG DEVICES	G6000580

Plunger Board Schematic

Plunger Board / Force Preamplifier

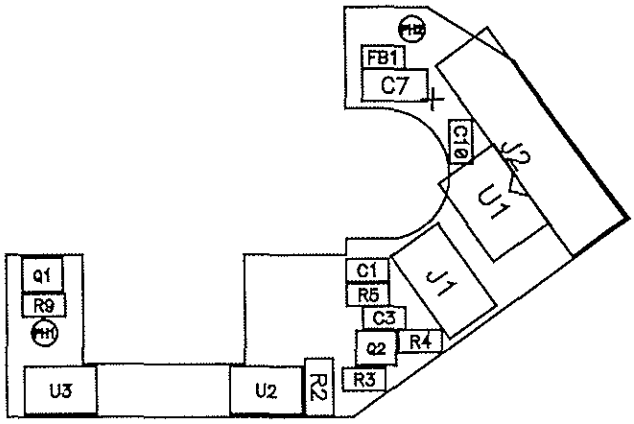


Plunger Board / Flipper Sensor

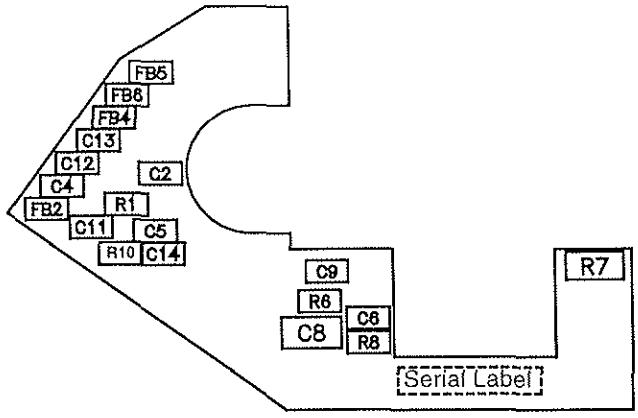


Plunger Board Assembly Drawing

Top Side:



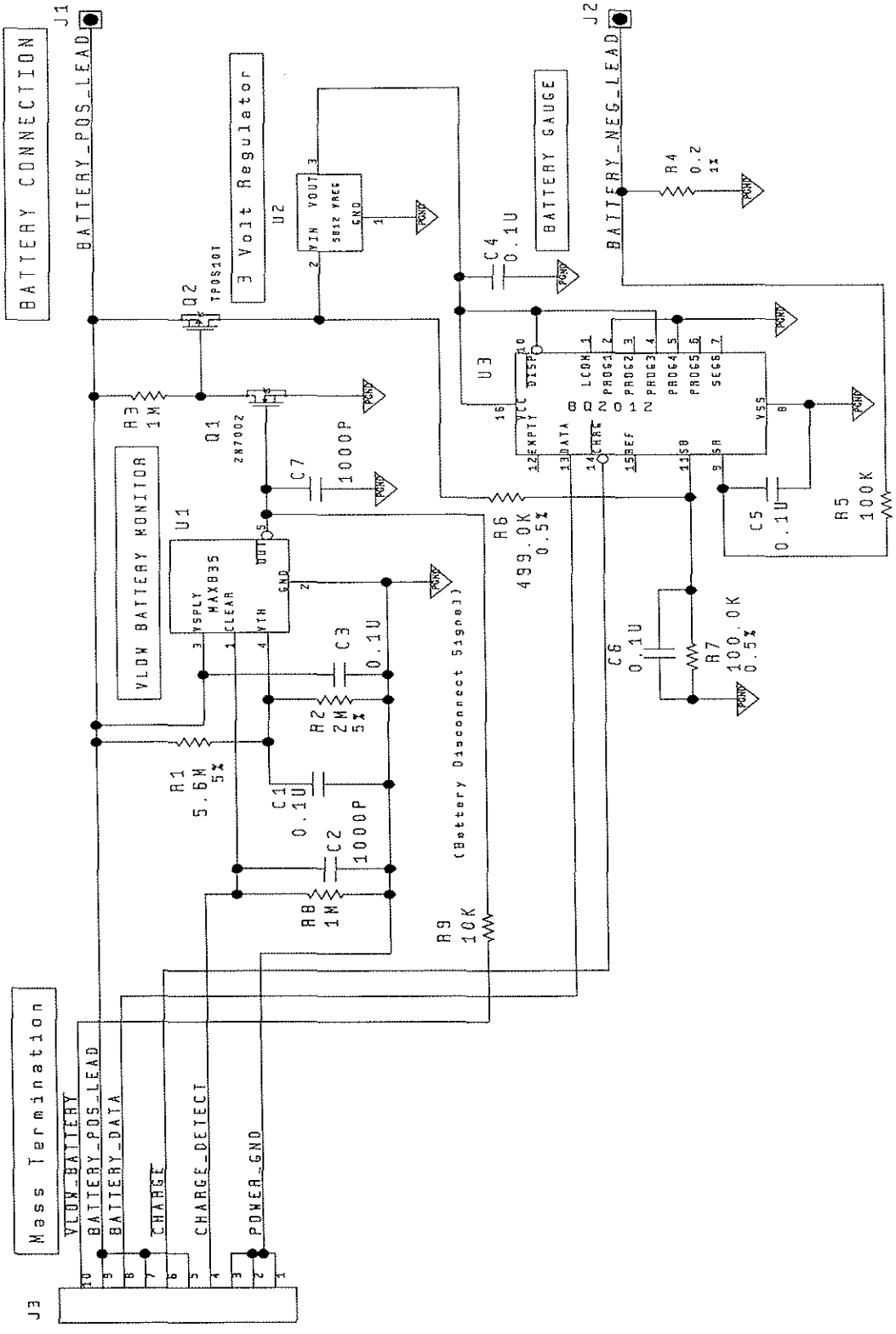
Bottom Side:



Plunger Board Assembly – Parts list

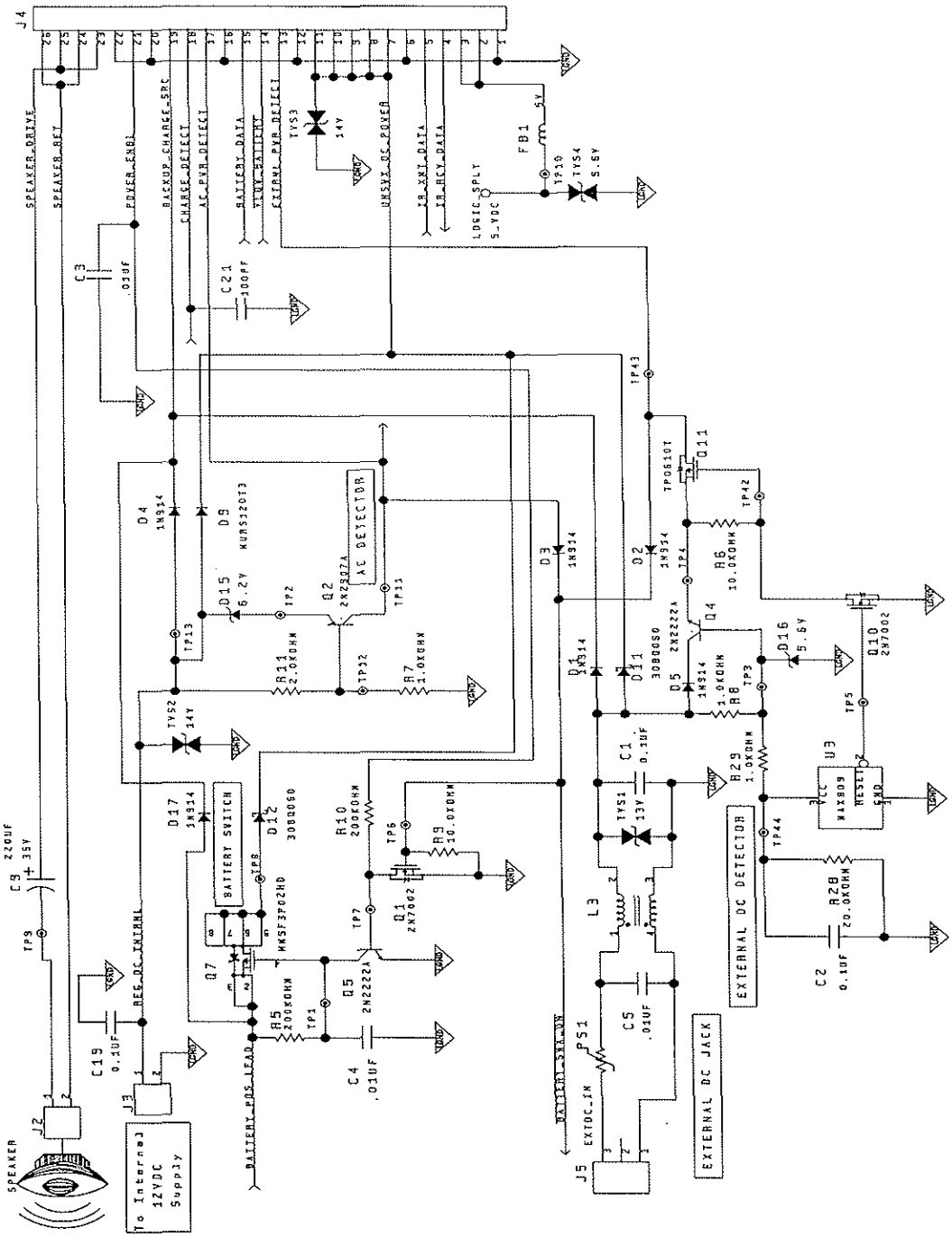
#	QTY	REF DESIGNATOR	PACKAGE	VALUE	PART SPEC	MEDEX P/N
1	12	C1, C2, C3, C4, C5, C6, C9, C10, C11, C12, C13, C14	0603	470PF	CERAMIC, 50V, NP0, 2%, 0603; GMC10CG471G50NT, CAL-CHIP	G6000248
2	1	C7	TANT_A	1U	CAPACITOR, 16V, TANT, 20%, SMT_A; TCMIC105AT, CAL-CHIP; TAJA105M016R, AVX	6B90010500
3	1	C8	1206	0.1UF	CAPACITOR, 50V, X7R, 10%, 1206; GMC31X7R104K50NT, CAL-CHIP 12065C104KAT2A; AVX	6B10010400
4	5	FB1, FB2, FB4, FB5, FB6	0603		BLM11A102SGPT, MURATA ERIE	G6000247
5	1	J1	4PINSMTHDR_WBOSS		90814-0004, MOLEX	G6000145
6	1	J2	11PIN_1_5MMSMTHDR		B11B-ZR-SM3-TF, JST	G6000146
7	1	Q1	SOT23		MMBT2222ALT1, ON-SEMI CMPT2222ATR or TR13; CENTRAL SEMICONDUCTOR	6Q10000300
8	1	Q2	SOT23		TP0610T, TEMIC	6Q10000200
9	2	R1, R10	0603	267.0OHM	RESISTOR, 1/16W, TCR=100PPM, 1%, 0603; RM06F2670CT, CAL-CHIP	G6000249
10	1	R2	0805	2.7MOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J275CT, CAL-CHIP	6A20027500
11	3	R3, R6, R8	0603	24.9KOHM	RESISTOR, 1/16W, TCR=100PPM, 1%, 0603; RM06F2492CT, CAL-CHIP	G6000246
12	3	R4, R5, R9	0603	2.0KOHM	RESISTOR, 1/16W, TCR=100PPM, 1%, 0603; RM06F2001CT, CAL-CHIP	G6000250
13	1	R7	0805	100OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J101CT, CAL-CHIP	6A20010100
14	1	U1	SO8		LT1167CS8, LINEAR TECHNOLOGY; AD620AR, ANALOG DEVICES	G6000217
15	2	U2, U3	RPI_LEADED OPTO		RPI-352, ROHM	G6000132
16	1	PCB			PCB RAW	G6000113

Battery Gauge Schematic

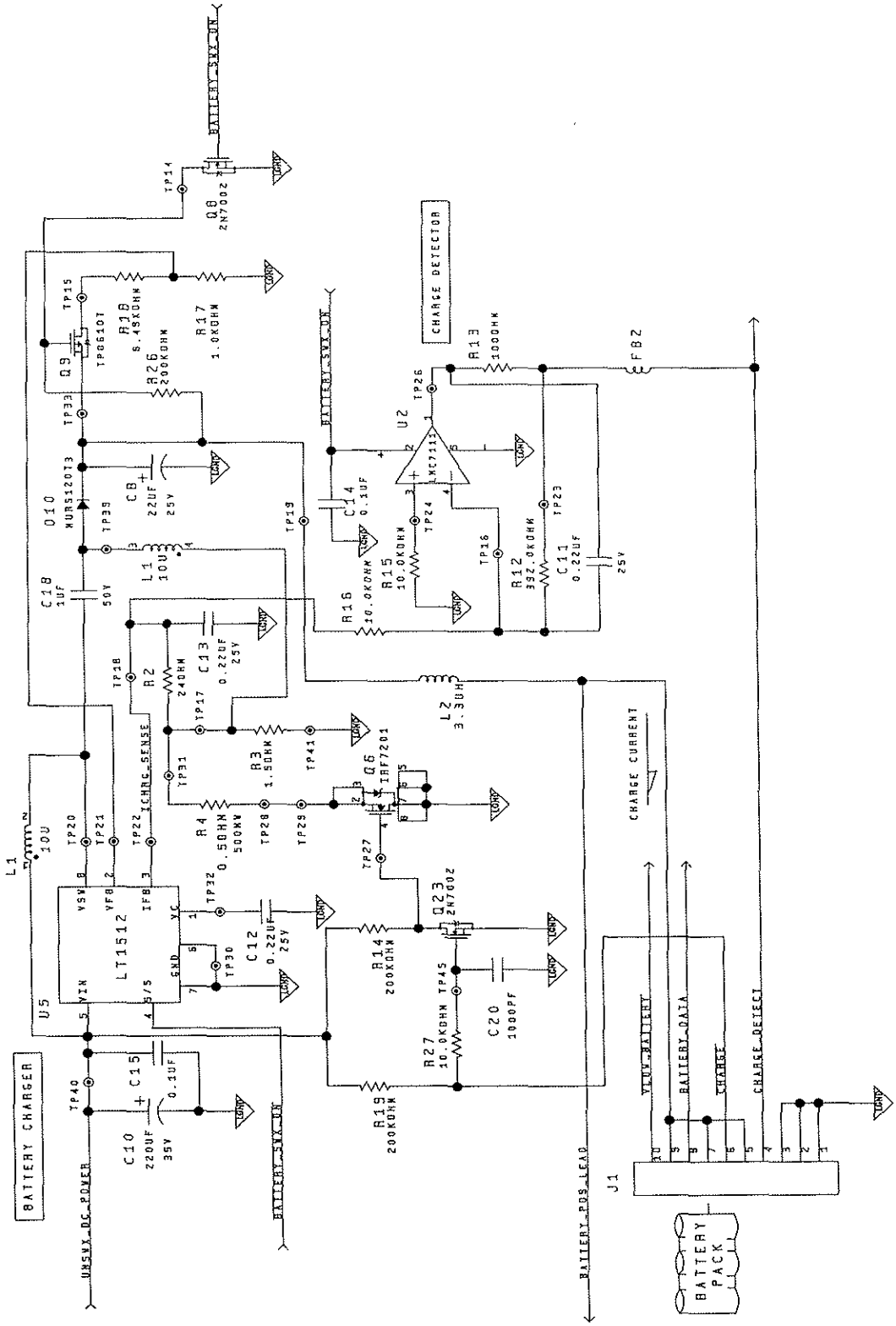


Interconnect Board Schematic

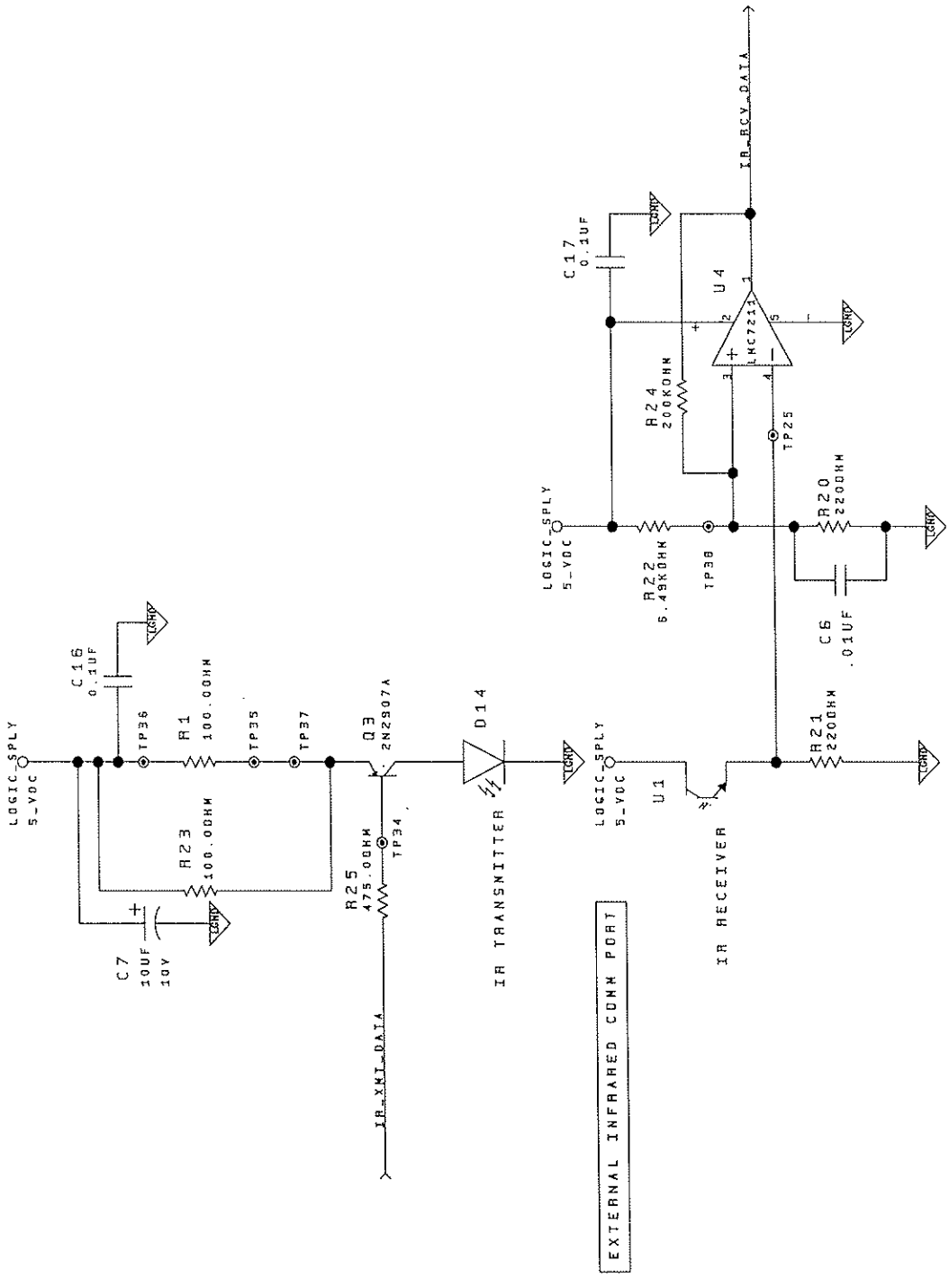
Interconnect Board / Power Control



Interconnect Board / Battery Management

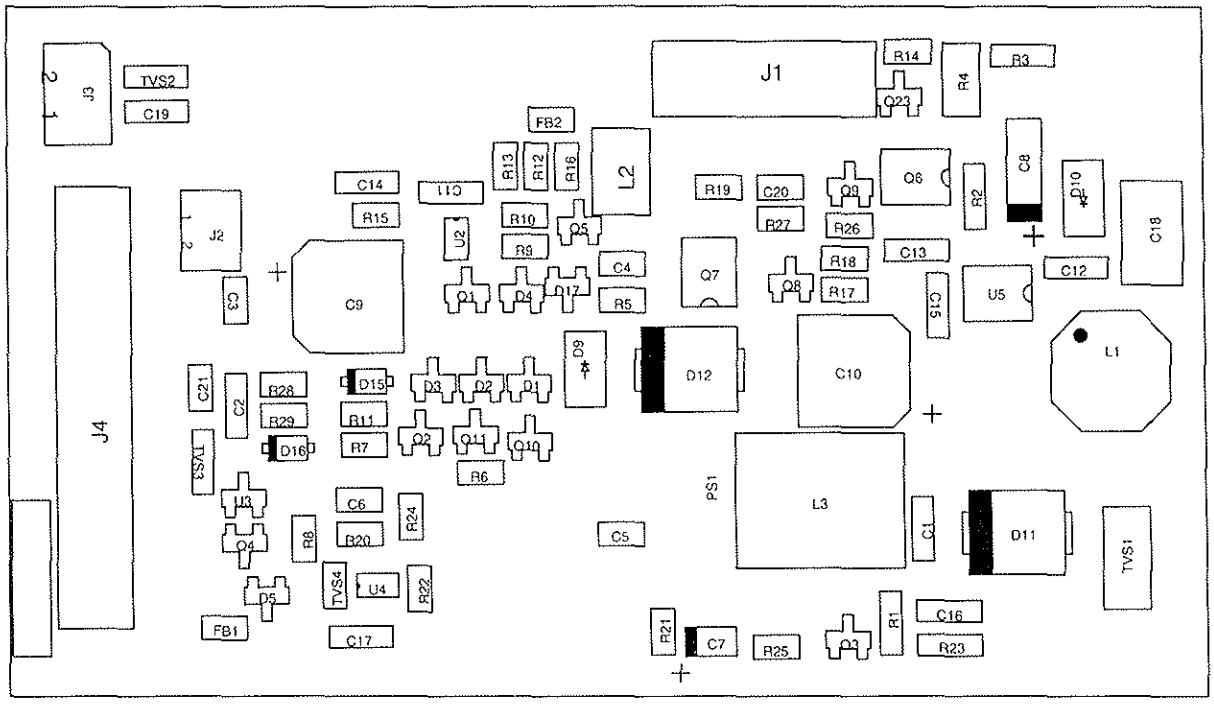


Interconnect Board / Infrared Serial Communications

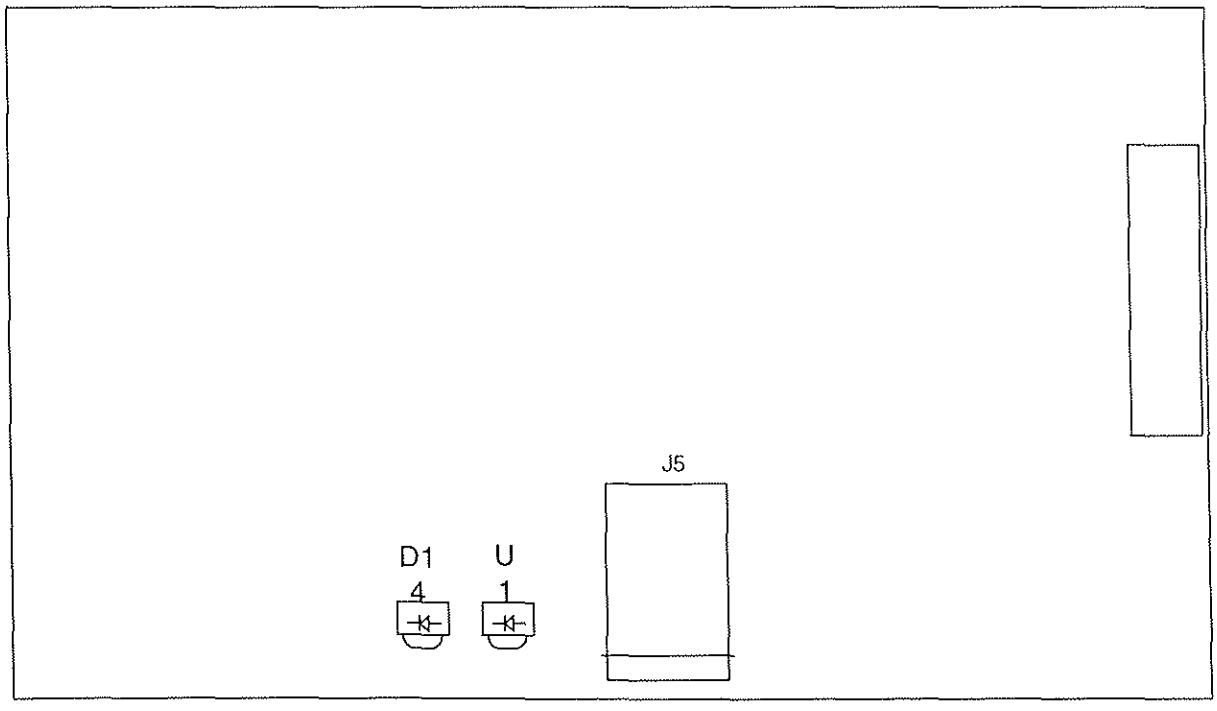


Interconnect Board Assembly Drawing

Top Side:



Bottom Side:



Interconnect Board Assembly – Parts list

#	QTY	REF DESIGNATOR	PACKAGE	VALUE	PART SPEC	MEDEX P/N
1	7	C1, C2, C14, C15, C16, C17, C19	1206W	0.1UF	CAPACITOR, 50V, X7R, 10%, 1206; GMC31X7R104K50NT, CAL-CHIP	6B10010400
2	4	C3, C4, C5, C6	0805W	.01UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R103K50NT, CAL-CHIP	6B20010300
3	1	C7	TANT_B	10UF	CAPACITOR, 10V, TANT, 20%, SMT_B; TCMIA106BT, CAL-CHIP; TAJB106M010R, AVX; T491B106M010AS, KEMET	6B90010600
4	1	C8	TANT_D	22UF	CAPACITOR, 25V, TANT, 10%, SMT_D; TPSD226M025R0200, AVX; T495D226M025AS, KEMET	6B90022600
5	2	C9, C10	SMT_8X10_8	220UF	CAPACITOR, 35V, ELECT, 20%, RADIAL; NACZ221M35V8X10.8TR13, NIC; 35VCV220GX, SURGE COMPONENTS	6B00022700
6	3	C11, C12, C13	1206W	0.22UF	CAPACITOR, 25V, X7R, 10%, 1206; GMC31X7R224K25NE, CAL-CHIP	6B10022400
7	1	C18	1825	1UF	CERAMIC, 1UF, 50V, X7R, 10%, 1825; GMC45X7R105K50NT, CAL-CHIP	G6000271
8	1	C20	0805W	1000PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG102J50NT, CAL-CHIP	6B20010200
9	1	C21	0805W	100PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG101J50NT, CALCHIP	6B20010100
10	6	D1, D2, D3, D4, D5, D17	SOT23		MMBD914LT1, MOTOROLA	6D20000100
11	2	D9, D10	SMB_X		MURS120T3, MOTOROLA; CMR1U-02, CENTRAL SEMICONDUCTOR	6D30000300
12	2	D11,D12	SMC		CMSH3-60, CENTRAL SEMI; 30BQ060, INTERN. RECTIFIER	6D30000100
13	1	D14	LEADED_IR		DN504, STANLEY	G6000188
14	1	D15	SOD-123	6.2V	MMSZ5234BT1, MOTOROLA	G6000143
15	1	D16	SOD-123	5.6V	MMSZ5232BT1, MOTOROLA	G6000170
16	2	FB1,FB2	0805W		BLM21A102SPT, MURATA ERIE	6FB0000100
17	1	J1	10P_079RATHHDR		1306-10-R-02, SINGATRON	G6000232
18	1	J2	2P_079THHDR		B2B-PH-K, JST	G6000167
19	1	J3	2P_100THHDR		22-03-5025, MOLEX	G6000144
20	1	J4	UNUSED			
21	1	J5	DC_JACK		DC-001-B-CRSN, POWER DYNAMICS	G6000172
22	1	L1	SMT_TOROID	10U	10UH, +/-20%, SMT TOROID; CTX10-1, COILTRONIX; 618-100M-01, C&K MAGNETICS	G6000273
23	1	L2	SMT_INDUCTOR1	3.3UH	3.3UH, +/-10%, SMT INDUCTOR; NL453232-3R3K, CAL-CHIP; IMC-1812 3.3UH 10%, DALE	G6000230
24	1	L3	TH_10MMX7_5MM		PLT2003C, MURATA ERIE	G6000174
25	1	PS1	POLYSW_RADIAL		RUE185, RAYCHEM	G6000175
26	4	Q1, Q8, Q10, Q23	SOT23		2N7002-T1, TEMIC; CENTRAL SEMICONDUCTOR	6Q10000100
27	2	Q2, Q3	SOT23		MMBT2907ALT1, MOTOROLA;	G6000176
28	2	Q4, Q5	SOT23		MMBT2222ALT1, MOTOROLA	6Q10000300
29	1	Q6	SO8		IRF7201, INTERN. RECTIFR; SI9410DY, TEMIC	6Q00000100

30	1	Q7	SO8		MMSF3P02HD,MOTOROLA; SI9430DY,SILICONIX (TEMIC)	6Q00000200
31	2	Q9, Q11	SOT23		TP0610T, SILICONIX (TEMIC);	6Q10000200
32	2	R1, R23	1206W	100.0OHM	RESISTOR, 1/8W, TCR=100PPM, 1%, 1206; RM10F1000CT, CAL-CHIP	G6000195
33	1	R2	1206W	24OHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J240CT, CAL-CHIP; ERJ-8GEYJ240V, PANASONIC	6A10024000
34	1	R3	1206W	1.5OHM	RESISTOR, 1/8W, TCR=400PPM, 1%, 1206; ERJ8RQF1R5V, PANASONIC; RM12F1R5CT, CAL-CHIP; WCR12062R49F, IRC	6A1001R500
35	1	R4	2010	0.5OHM	RESISTOR, 1/2W, TCR=100PPM, 1%, 2010; WSL2010R500F, DALE; LR2010001R500F, IRC	6A0000R500
36	6	R5, R10, R14, R19, R24, R26	0805W	200KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J204CT, CAL-CHIP	6A20020400
37	5	R6, R9, R15, R16, R27	0805W	10.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1002CT, CAL-CHIP	6A20100200
38	4	R7, R8, R17, R29	0805W	1.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1001CT, CAL-CHIP	6A20100100
39	1	R11	0805W	2.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2001CT, CAL-CHIP	G6000154
40	1	R12	0805W	392.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F3923CT, CAL-CHIP	6A20392300
41	1	R13	0805W	100OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J101CT, CAL-CHIP	6A20010100
42	2	R18, R22	0805W	6.49KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F6491CT, CAL-CHIP	G6000165
43	2	R20, R21	0805W	220OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J221CT, CAL-CHIP	6A20022100
44	1	R25	0805W	475.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4750CT, CAL-CHIP	G6000155
45	1	R28	0805W	20.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2002CT, CAL-CHIP	6A20200200
46	1	TVS1	DO_204AC		SA13CA, ON-SEMI; SA13CA VISHAY SEMICONDUCTOR	G6000189
47	2	TVS2, TVS3	1206W		VC120614D300D, AVX	G6000177
48	1	TVS4	0805W		VC080505A150, AVX	6TS0000100
49	1	U1	LEADED_IR		PS5042, STANLEY	G6000190
50	1	U2	SOT23-5		LMC7111BIM5, NATIONAL SEMICONDUCTOR; MIC7111BM5, MICREL	6U00000100
51	1	U3	SOT23		MAX809LEURT, MAXIM; ADM809LART, ANALOG DEVICES	6U00000900
52	1	U4	SOT23-5		LMC7211AIM5, NATIONAL SEMICONDUCTOR; MIC7211BM5, MICREL	6U00000600
53	1	U5	SO8		LT1512CS8, LINEAR TECH	6U00001200
54	1	PCB	N/A		INTERCONNECT PCB RAW, 3000 Series	G6000311

PART 7: ASSEMBLY DRAWINGS & PARTS LISTS

Assembly Drawings

The following pages provide assembly drawings – exploded views, and detailed parts lists including Medex part numbers.

Always follow the procedures (including warnings/cautions) in "Parts Replacement" section of this manual while disassembling, replacing parts, and reassembling any 3000 Series infusion pump.

3000 Series Main Pump Assembly

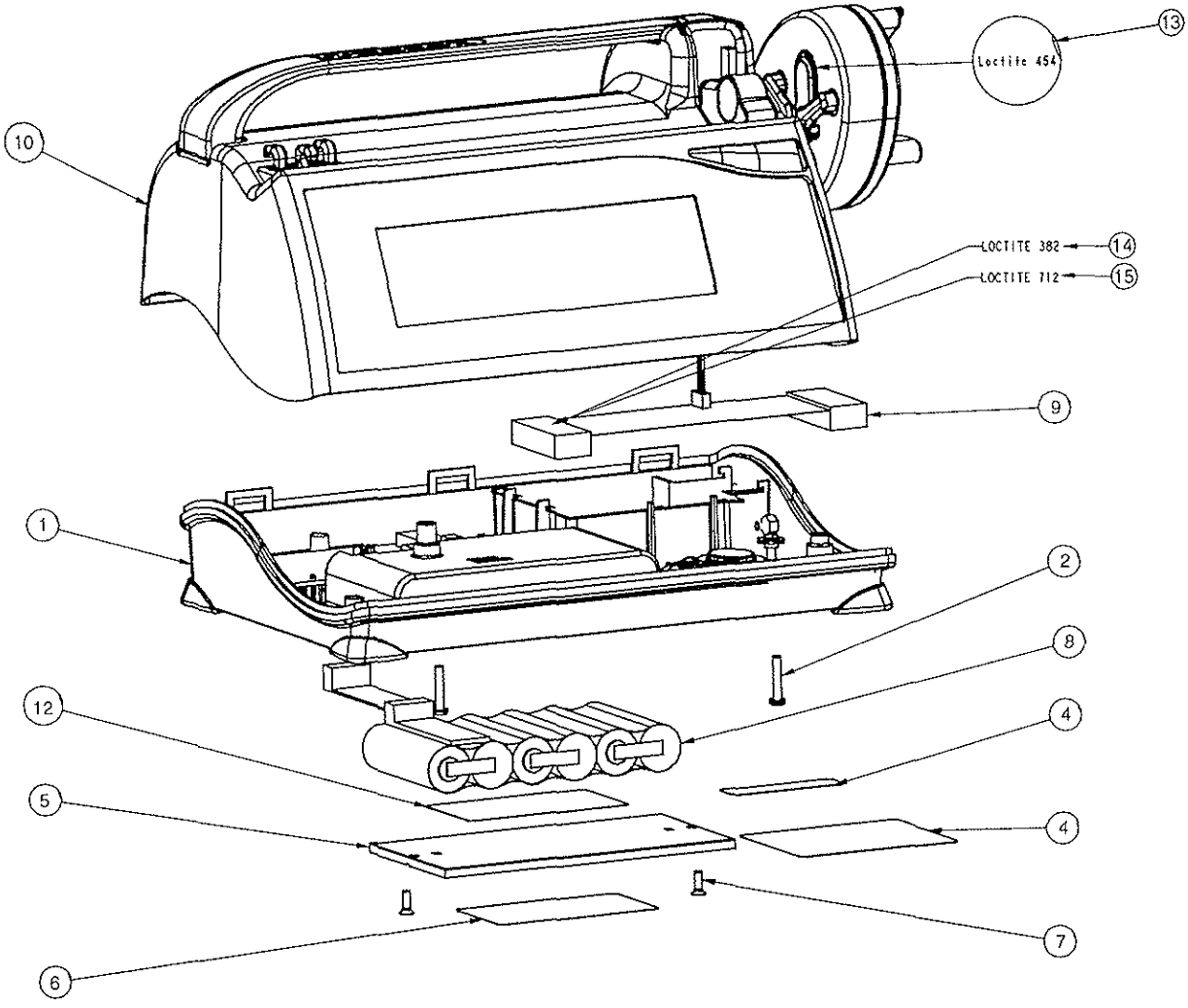


Illustration of Protégé ™ 3010 Main Assembly

3000 Series Main Pump Assembly – Parts list

Ref. #	Medex P/N	Description	Quantity
1	See following	ASSEMBLY CASE BOTTOM	1 EA
2	G6000059	SCREW 4-40X.62 PH PHILLIPS	2 EA
3	G6000123	LABEL, DEVICE TRACKING	1 EA
4	G6000291	LABEL WARNING	1 EA
5	G6000112	DOOR, BATTERY BAY	1 EA
6	G6000336	LABEL SERIAL NUMBER	1 EA
7	G6000117	SCREW 4-40X.31 FH SS	2 EA
8	G6000244	BATTERY ASSY, 3000	1 EA
9	G6000387	INTERCONNECT CABLE ASSY, 3000 SERIES	1 EA
10	See following	ASSEMBLY CASE TOP W/ PLUNGER HEAD	1 EA
12	G6000356	BATTERY WARNING LABEL	1 EA
13	G6000321	LOCTITE 454 GEL ADHESIVE	0.01 OZ

Notes:

1. The battery warning label (item 12) is being replaced with the international battery warning label, Medex part number G6000356.
2. The serial number label (item 6) is being replaced with the international serial number label, Medex part number G6000336.

Case Bottom Assembly

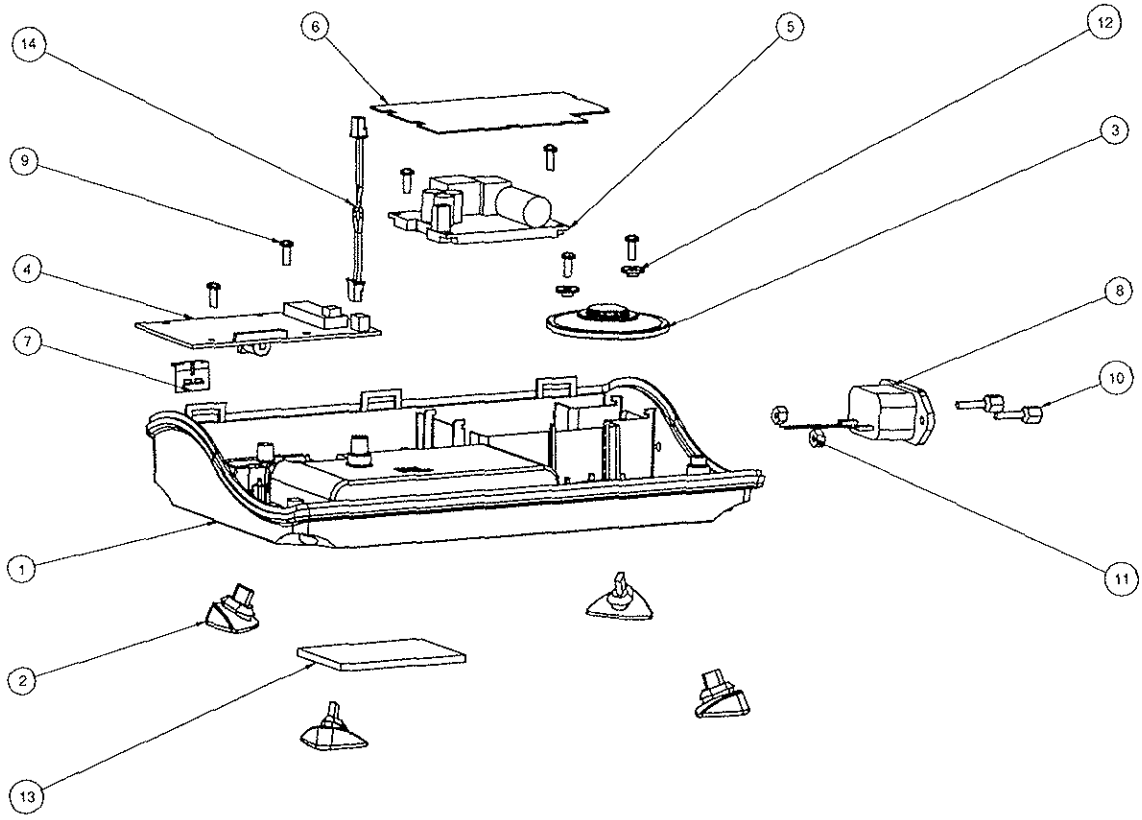


Illustration of Case Bottom Assembly

Case Bottom Assembly – Parts list

See also case bottom service assembly, note 4 below.
To obtain replacement labels with the CE mark and national language, international customers must order the International Case Bottom Assy. See note 4 below.

Ref. #	Medex P/N	Description	Quantity
1	G6000094	CASE BOTTOM	1 EA
2	G6000287	ENLARGED RUBBER FOOT	4 EA
3	G6000014	SPEAKER, ASSEMBLY	1 EA
4	G6000312	PCB ASSEMBLY, INTERCONNECT	1 EA
5	G6000423	POWER SUPPLY, CONFORMAL COATED	1 EA
6	G6000016	SHIELD, POWER SUPPLY	1 EA
7	G6000017	LENS, IR WINDOW	1 EA
8	G6000276	CABLE, AC POWER	1 EA
9	G6000063	SCREW, 4-40X.31 PH PHILLIPS	6 EA
10	G6000220	CLAMP, CORD RETAINER	1 EA
11	G6000192	LOCKNUT, 6BA NYLOCK	2 EA
12	G6000410	WASHER, SHOULDER, NYLON	2 EA
13	G6000118	PAD, BATTERY BAY	1 EA
14	G6000012	CABLE, DC POWER	1 EA

Notes:

1. In newer assemblies, the interconnect PCB assembly (item 4) P/N G6000312 has superceded the older assembly P/N G6000234.
2. In older assemblies, items 10 & 11 are SCREW, 4-40X.38 FH SS (G6000127) and NUT, 4-40 NYLOCK (G6000043).
3. In newer assemblies, the shoulder washer (item 12) has superceded the flat washer, Medex P/N G6000058.
4. Items 1, 2 (four pieces), 7, 13 and labels are available as a service subassembly part number
   English: G6000438, CASE BOTTOM ASSEMBLY - SERVICE.
   International: G6000622, CASE BOTTOM ASSY INTERNATIONAL – SERVICE.

Case Top Assembly w/Plunger

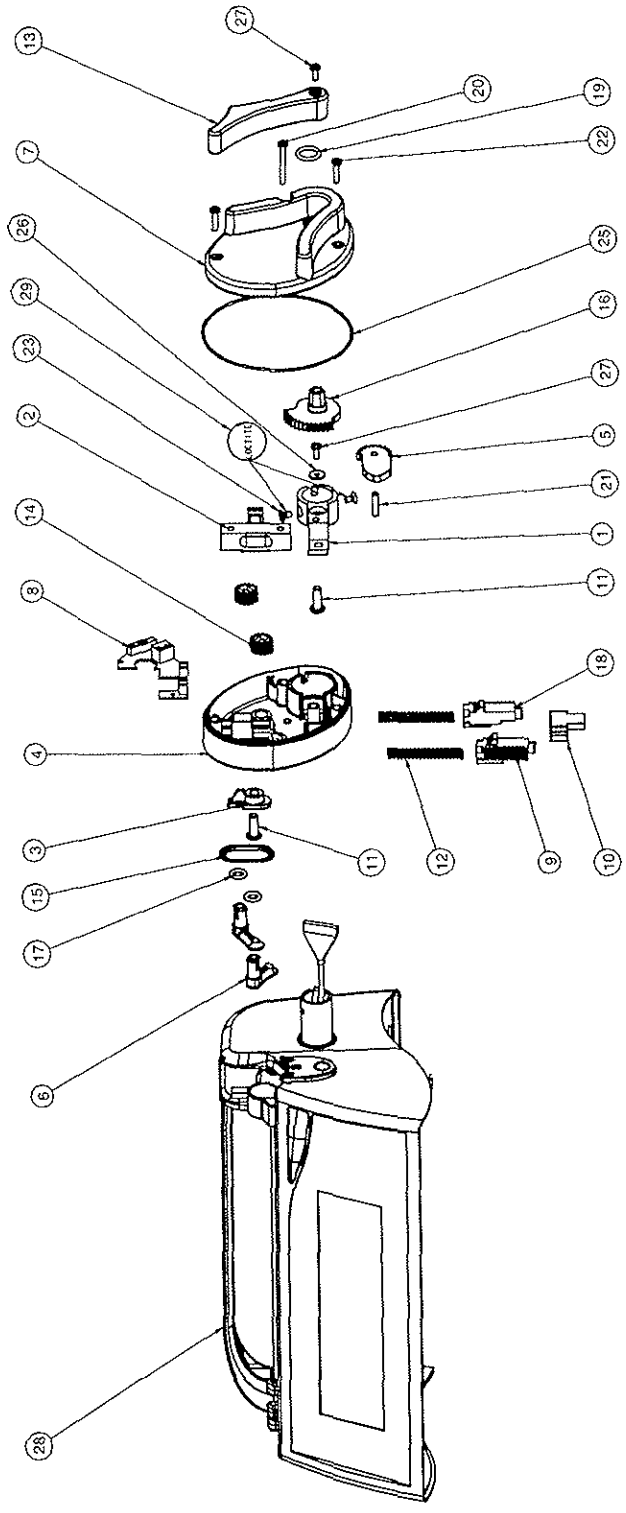


Illustration of Case Top Assembly w/Plunger

Case Top Assembly w/Plunger – Parts list

See also plunger case left service assembly, note 1 below.

Ref. #	Medex P/N	Description	Quantity
1	G6000067	MOUNT, PLUNGER HEAD	1 EA
2	G6000068	FORCE SENSOR	1 EA
3	G6000069	PLATE, PLUNGER FLOAT	1 EA
4	G6000070	CASE LEFT, PLUNGER	1 EA
5	G6000071	CAM GEAR, PLUNGER	1 EA
6	G6000472	FLIPPER, PLUNGER	2 EA
7	G6000074	CASE RIGHT PLUNGER	1 EA
8	G6000434	ASSY PCB PLUNGER, TESTED SERVICE	1 EA
9	G6000081	TIMING PLATE LEFT	1 EA
10	G6000084	PUSH BLOCK	1 EA
11	G6000085	SCREW, M4X12, BUTTON HEAD	2 EA
12	G6000086	SPRING, .21 OD X 1.5	2 EA
13	G6000088	LEVER, PLUNGER	1 EA
14	G6000089	GEAR, PLUNGER FLIPPER	2 EA
15	G6000091	SEAL, FLOAT PLATE	1 EA
16	G6000087	GEAR, PLUNGER LEVER	1 EA
17	G6000082	SEAL, FLIPPER	2 EA
18	G6000114	TIMING PLATE RIGHT	1 EA
19	G6000083	SEAL, LEVER	1 EA
20	G6000103	SCREW 4-40 x 7/8 PAN PHIL SS	1 EA
21	G6000110	PIN, DOWEL	1 EA
22	G6000105	SCREW, 4-40X7/16 PAN PHIL SS	2 EA
23	G6000106	SCREW, 4-40X.18 FH SS	2 EA
25	G6000090	SEAL, PLUNGER CASE	1 EA
26	G6000474	WASHER, FLAT #4, SS	1 EA
27	0429025200	SCREW, PAN PHIL, 4-40 1/4 SS	2 EA
28	See following	ASSY, CASE TOP W/O PLUNGER	1 EA
29	036LT24200	LOCTITE 242	0.01 OZ

Notes:

1. Items 3, 4, 6 (two pieces), 14 (two pieces), 15, and 17 (two pieces) are available as a service subassembly part number G6000439, PLUNGER CASE LEFT ASSEMBLY - SERVICE.

Case Top Assembly Without Plunger

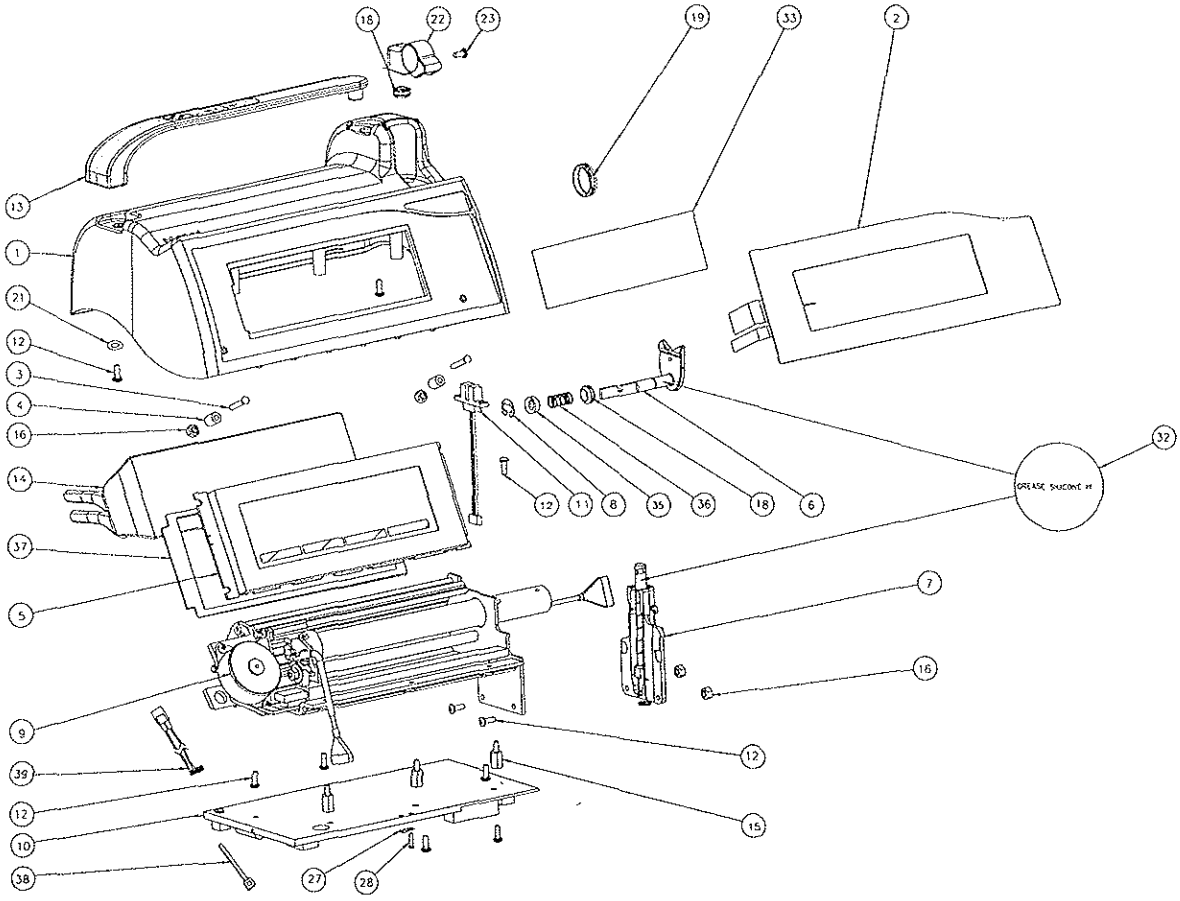


Illustration of Assembly, Case Top, Without Plunger

Case Top Assembly without Plunger – Parts list

See also case top service assembly, note 2 below.

Ref. #	Medex P/N	Description	Quantity
1	G6000289	CASE TOP, WITH TUBING HOLDERS	1 EA
2	See note 4.	KEYPAD 3000	1 EA
3	G6000021	STUD SELF CLENCH 4-40 X 625	2 EA
4	G6000022	SPACER, .25 OD X .31,NYLON	2 EA
5	G6000625	DISPLAY, LIQUID CRYSTAL,	1 EA
6	G6000023	EAR CLIP	1 EA
7	See following	ASSEMBLY BARREL CLAMP	1 EA
8	G6000034	E RING	1 EA
9	See following	ASSEMBLY DRIVE TRAIN	1 EA
10	See note 3.	ASSY 3000 MAIN PCB	1 EA
11	G6000010	OPTOCOUPLER ASSEMBLY	1 EA
12	G6000063	SCREW 4-40X.31 PHILLIPS	10 EA
13	G6000390	CASE HANDLE	1 EA
14	G6000101	BACKLIGHT FIBER OPTIC (3010a Series)	1 EA
	G6000582	BACKLIGHT FIBER OPTIC DUAL LED (3500 SERIES)	
15	G6000064	STANDOFF HEX 4-40 X .38	3 EA
16	G6000043	NUT 4-40 NYLOCK	4 EA
18	G6000122	SEAL, BARREL CLAMP/EAR CLIP	2 EA
19	G6000077	TUBE SEAL	1 EA
20	G6000142	LABEL, PROTEGE LOGO	1 EA
	G6000541	LABEL, MEDFUSION 3010A LOGO	
	G6000605	LABEL MEDFUSION 3500 LOGO	
21	G6000474	O-RING, .110 ID X .063	2 EA
22	G6000030	BARREL CLAMP HEAD	1 EA
23	G6000104	SCREW 4-40X.25 BH BLACK	1 EA
27	G6000257	CLAMP, STAINLESS STEEL	1 EA
28	0419031200	SCREW, PAN PHIL 2-56 5/16 SS	1 EA
32	0382000000	GREASE, SILICONE 111	0.1 OZ
33	G6000339	LENS, KEYPAD SUPPORT	1 EA
34	0362000000	TAPE, DOUBLE COATED	0.52 FT
35	G6000393	SLEEVE, EAR CLIP	1 EA
36	G6000397	SPRING, EAR CLIP	1 EA
37	G6000583	SPACER, LCD, BACKLIGHT	Note 5 EA
38	039TT10200	WIRE TIE (3500 SERIES)	1 EA
39	G6000585	CABLE, BACKLIGHT DUAL LED (3500 SERIES)	1 EA

Notes:

1. Item 35 does not appear in older pumps.
2. Items 1, 2, 3 (two pieces), 13, 20, 33 and 34 are available as a service subassembly part number
   For 3010: G6000437, CASE TOP PROTEGE ASSEMBLY - SERVICE.
   For 3500 (English): G6000610, CASE TOP 3500 – SERVICE
   For 3500 (International): G6000624, 3500 INTERNATIONAL CASE TOP - SERVICE
3. Items 10 is available as service subassembly part numbers:
   G6000435, 3010 MAIN PCB ASSEMBLY – **SOFTWARE VERSION 2.0.6** - SERVICE.
   G6000361, 3500 MAIN PCB ASSEMBLY – **SOFTWARE VERSION 3.0.1** - SERVICE
   Check with Medex service department for other software versions.
4. Item 2, for 3010 English Text Keypad use G6000005.
   for 3500 English Text keypad use G6000607.
   for 3500 International Keypad use G6000277.
5. Early 3010 pumps have no spacer, later 3010 pumps have 2 spacers. All 3500 and later pumps have 1 spacer.

Barrel Clamp Assembly

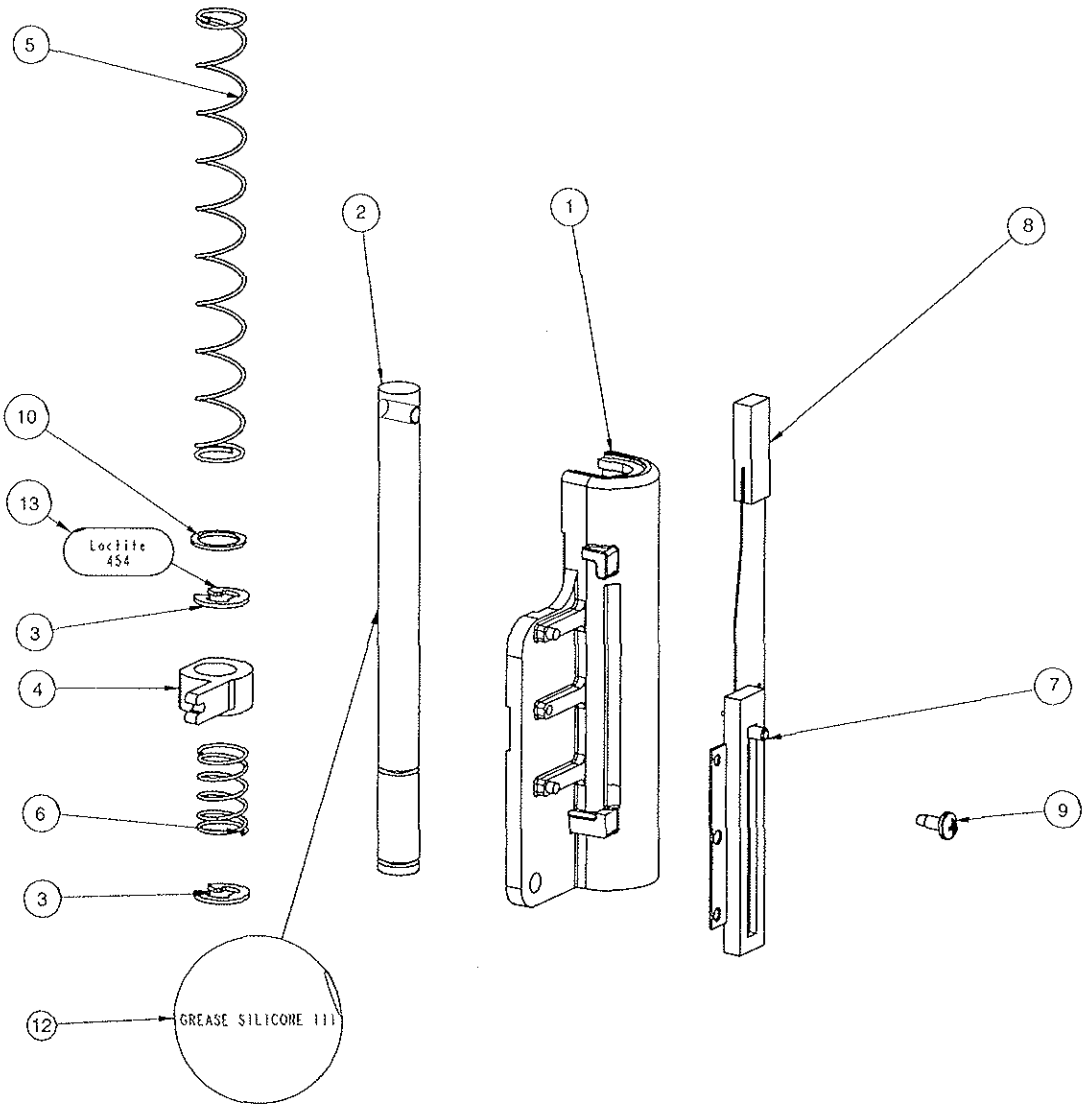


Illustration of Barrel Clamp Assembly

Barrel Clamp Assembly – Parts list

Ref. #	Medex P/N	Description	Quantity
1	G6000026	GUIDE BARREL CLAMP	1 EA
2	G6000027	ROD BARREL CLAMP	1 EA
3	0391331800	E-CLIP	2 EA
4	G6000031	BARREL CLAMP SLIDE	1 EA
5	G6000032	SPRING, BARREL CLAMP	1 EA
6	G6000024	SPRING .265 ID X .5	1 EA
7	See note 1.	POT SIZE SENSOR, 10K	1 EA
8	See note 1.	FLEX CABLE SIZE POT	1 EA
9	G6000121	SCREW #2X.18 PLASTITE	1 EA
10	G6000080	WASHER BARREL CLAMP	1 EA
11	0340IF1400	.030 DIA, SPOOL SOLDER	0.01 OZ
12	0382000000	GREASE, SILICON 111	0.1 OZ
13	G6000321	LOCKTITE, 454 GEL ADHESIVE	0.01 OZ

Notes:

1. These items 7 and 8 are available as a service subassembly part number G6000436, SIZE SENSOR POT ASSEMBLY - SERVICE.
2. In newer assembles, items 2, 3, 10, and 13 have been combined into one new part G6000368, BARREL CLAMP ROD.

Drive Train Assembly

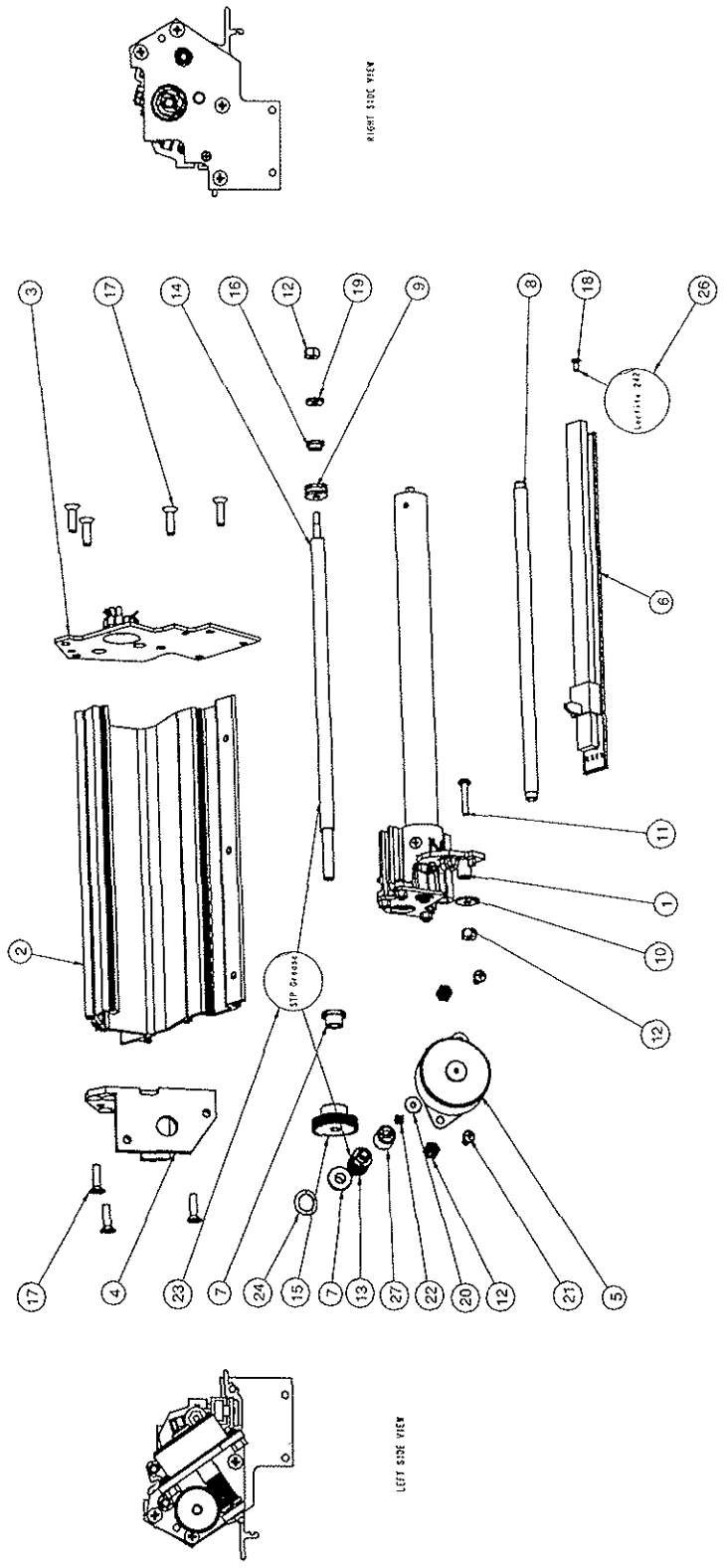


Illustration of Drive Train Assembly

Drive Train Assembly - Parts list

Ref. #	Medex P/N	Description	Quantity
1	See following	ASSEMBLY CLUTCH	1 EA
2	G6000047	EXTRUSION MAIN	1 EA
3	G6000262	ASSY RIGHT END PLATE W/ GRD RING	1 EA
4	G6000049	PLATE MOTOR MOUNT	1 EA
5	See note 2.	MOTOR STEPPER 7.5 DEGREE	1 EA
6	G6000095	POT POSITION 10K, 20%	1 EA
7	G6000053	BUSHING .19 ID X .25 DELRON	2 EA
8	G6000055	ROD, GUIDE, PRECISION	1 EA
9	G6000056	THRUST BEARING	1 EA
10	G6000058	WASHER STEEL .438 X .125 X .031	1 EA
11	G6000059	SCREW 4-40X.62 PH PHILLIPS	1 EA
12	G6000043	NUT 4-40 NYLOCK	4 EA
13	See note 1.	WORM	1 EA
14	G6000054	LEADSCREW	1 EA
15	G6000051	GEAR, WORM	1 EA
16	G6000057	BUSHING, LEADSCREW, RIGHT	1 EA
17	G6000075	SCREW 6-20X.5 FH THREAD FORM	7 EA
18	G6000108	SCREW, 2-56X.19 FH SS	1 EA
19	G6000072	WASHER BRASS .340X.117X.050	1 EA
20	See note 2.	WASHER, TEFLON, .312X.093X.010	1 EA
21	G6000063	SCREW 4-40X.31 PH PHILLIPS	2 EA
22	See note 2.	SHAFT DRIVER	1 EA
23	07020STP00	GREASE, STP	0.1 OZ
24	G6000325	WASHER, WAVE SPRING,.490X.326X.010	1 EA
26	036LT24200	LOCTITE 242	0.01 OZ
27	See note 1.	COUPLING, WORM	1 EA

Notes:

1. Items 13 and 27 are pressed together to form a worm assembly, in older pumps these may appear as a single machined part. These items are available as a service subassembly part number G6000432, WORM/COUPLING ASSEMBLY - SERVICE.
2. Items 22, 20, and 5 are available as a service subassembly part number G6000431, MOTOR SERVICE ASSEMBLY - SERVICE.

Clutch Assembly

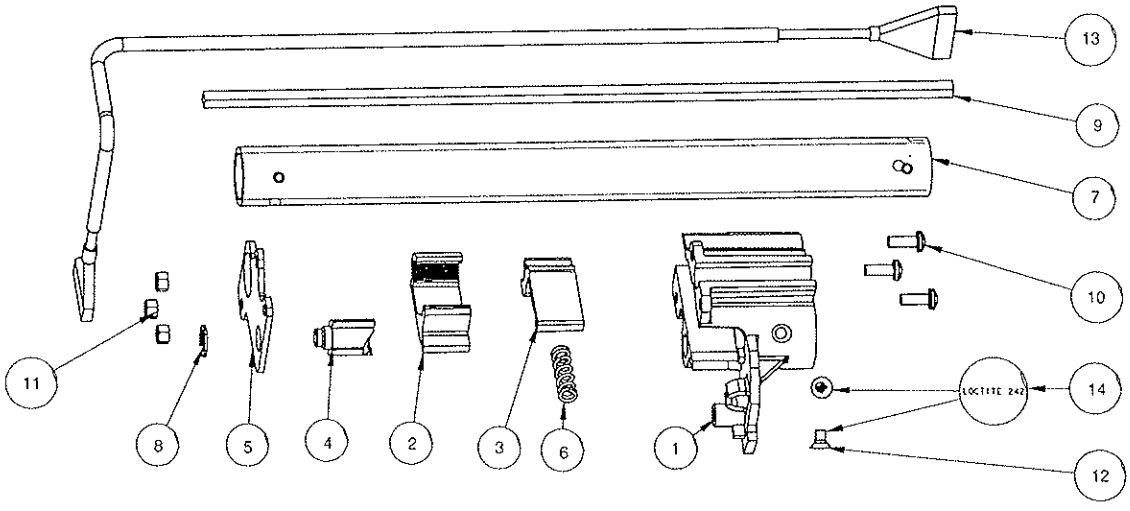


Illustration of Clutch Assembly

Clutch Assembly – Parts list

Ref. #	Medex P/N	Description	Quantity
1	G6000099	CARRIAGE	1 EA
2	G6000037	CLUTCH LEFT	1 EA
3	G6000038	CLUTCH, RIGHT	1 EA
4	G6000039	CAM, CLUTCH	1 EA
5	G6000041	PLATE, CARRIAGE	1 EA
6	G6000044	SPRING, CLUTCH	1 EA
7	G6000045	TUBE PLUNGER	1 EA
8	0391331800	E-CLIP	1 EA
9	G6000046	SQUARE SHAFT	1 EA
10	G6000063	SCREW 4-40X.31 PH PHILLIPS	3 EA
11	G6000310	NUT, NYLOCK, 4-40, SS, SMALL	3 EA
12	G6000106	SCREW 4-40X.18 FH SS	2 EA
13	G6000159	ASSEMBLY, PLUNGER CABLE	1 EA
14	036LT24200	LOCTITE 242 THREADLOCK	0.01 OZ

Notes:

1. In newer pumps, square shaft (item 9) is being superceded by SS SQUARE SHAFT, P/N G6000378.

Accessories – Parts list

Pole clamp parts.

Medex P/N	Description	Quantity
G6000284	POLE CLAMP "C" BRACKET	1 EA
G6000286	POLE CLAMP "L" BRACKET	1 EA
G6000320	KNOB, ½-13 X 2", STAINLESS	1 EA
G6000297	SCREW, #8-32 X .38", PAN HEAD, STAINLESS	4 EA
G6000117	SCREW, #4-40 X .31", FLAT HEAD, STAINLESS	2 EA

Rotating Pole clamp parts.

Medex P/N	Description	Quantity
046L050200	¼-20X.5 BUTTON HEAD HEX	1 EA
0482004400	INDEX CAM	2 EA
0502002400	COMPRESSION SPRING	4 EA
0502003100	SHOULDER BUSHING	1 EA
G6000104	SCREW 4-40X.25 BH BLACK	4 EA
G6000284	POLE CLAMP "C" BRACKET	1 EA
G6000286	POLE CLAMP "L" BRACKET	1 EA
G6000288	#4 EXTERNAL CONICAL TOOTH LOCKWASHER	2 EA
G6000303	#8 INTERNAL LOCK WASHER SS	4 EA
G6000320	KNOB, ½-13 X 2", STAINLESS	1 EA
G6000345	SCREW #4-40 X 5/16, FH, LOCKING, SS	2 EA
G6000496	MOUNT, ROTOR ROTATING	1 EA
G6000497	ROTOR BASE	1 EA
G6000499	SCREW #8-32 X 55/16 PAN	4 EA
G6000505	INDEXING PLUNGER 3/8-24 THREAD	1 EA
G6000506	SCREW #8-32 X 5/16 PAN HEAD PHILLIPS NYLOK SS	4 EA
G6000538	ASSY, PLATE BACK	1 EA
G6000551	BRACKET, POLE CLAMP STOP	2 EA

Miscellaneous parts.

Medex P/N	Description	Quantity
G6000329	AC LINE CORD, NORTH AMERICAN, CLASS II	1 EA

G6000330	AC LINE CORD, UNITED KINGDOM, CLASS II	1 EA
G6000331	AC LINE CORD, CONTINENTAL EUROPEAN, CLASS II	1 EA

Calibration & Repair – Parts list

The Medex Biomed 3000 Series Calibration Kit

The *Biomed* 3000 Series Calibration Kit contains the tools necessary for performing the periodic maintenance and calibration of the 3000 Series infusion pumps.

3000 Series Calibration Kit – Medex P/N 3000CAL. This calibration kit contains the following items :

- 1 ea. – Small Calibration Slug, G6000235
- 1 ea. – Large Calibration Slug, G6000236
- 1 ea. – Analog Force Gauge, G6000294

Other Tools & Equipment Required to Service 3000 Series Pumps

The following tools are necessary for performing the maintenance, parts replacement, and diagnosis of the 3000 Series infusion pumps.

- 1 ea. – 50 or 60cc syringe (see Operations Manual for list of acceptable types)
- 1 ea. – Medium bore tubing set, Medex 53-60-225 or equivalent
- 1 ea. – 3 Way Stopcock
- 1 ea. – Torque Screwdriver with #1 Phillips bit, #0 Flat bit, & 2.5mm Hex bit
- 1 ea. – 3/16" nut driver
- 1 ea. – 1/4" open end wrench or nut driver
- 1 ea. – .002" shim or feeler gauge
- 1 ea. – Pliers, standard & needle nose

PART 8: APPENDICES

Appendix 1. Glossary of Technical Terms

This is a glossary of technical terms relating to the 3000 Series pumps.

AC Line Leakage Test	The pump is listed as Safety Class II, Type CF equipment. Protection against electrical shock does not rely only upon basic insulation, but instead relies on double or reinforced insulation. As such, this equipment does not use a third wire ground (earth ground). Therefore, when doing line leakage test it is not necessary to measure leakage in both the open ground and closed ground setting. Nor is it necessary or relevant to perform a ground resistance test. Protection against leakage current is the concern for any device [be it Class I or Class II] deriving power from AC mains. Leakage current is what flows from mains side to device component(s) that is conductive and accessible by the user or patient. Safety grounding of exposed metal does not protect the user from leakage current. Safety grounding causes a circuit breaker or fuse to open should a short occur between wall AC side and grounded metal. The 3000 Series pump achieves protection by double-isolating secondary power and exposed metal from AC power. The 3010 pump satisfies the UL requirement that *4000 volts can be applied between AC side and exposed metal without causing significant current to flow.*
Alarm History	See "view alarm history"
Alarm Message	The onscreen text which appears to indicate situations or circumstances requiring user attention.
Backup Audio Buzzer	The *backup audio buzzer* provides a means of generating an alarm during: • *instrument power loss* (while the instrument was on) • *malfunction of the main microprocessor* • or *failure of the primary speaker.* The backup audio buzzer activates during *Watchdog Alarm,* anytime there is a malfunction of the main microprocessor. During power-up self-tests, the buzzer is function is verified by briefly allowing the watchdog alarm to activate.
Backup Super Capacitor	A *1 Farad Super Capacitor* is part of the power control design to provide backup power to the audio buzzer in the loss of the primary power source.
Battery Gauge	The gauge circuits monitor direction and magnitude of current flowing through the battery. • The battery current is sensed by the gauge. • The gauge then computes capacity. To control charging the battery, the gauge uses battery temperature and battery voltage. The gauge changes to trickle charge in the event the battery temperature exceeds 50°C or if the battery voltage is lower than 5.7 volts.

Battery Parameters	There are two battery parameters requiring periodic inspection to maintain good battery performance. They can be accessed, by selecting Biomed Diagnostics, and then Monitor Battery Status options. • **LMD (Last Measured Discharge)** – This the *learned capacity* of the battery by the gauge following a calibration cycle. Replace the battery when this is *< 1400 mA-hours*. • **CPI (Capacity Inaccurate)** – This is the *number of shallow discharge cycles* since he last calibration. Always recalibrate the battery when CPI is *> 128*. Refer to the battery calibration section below.
Biomed *Calibration*	A set of functions for calibration/adjustment of the sensors within the 3000 Series pump. Steps and processes for using Biomed *Calibration* functions are found in section *Adjustment & Calibration*.
Biomed *Diagnostics*	A set of functions which allow the detailed examination of the pump's systems, sensors, indicators, and controls. Steps for using Biomed *Diagnostics* functions are found in sections *Scheduled Maintenance* and *Troubleshooting*.
Biomed *Utilities*	The set of Biomed *Utilities* contain a mixture of adjustment and troubleshooting options. These are: ***Set / View Last PM Date*** – This allows viewing the last recorded preventive maintenance date. This is where you also set the date when completing annual preventive maintenance. ***Set Time / Date*** – This is where you set date and time for built-in real time system clock. ***View Alarm History*** – This is a troubleshooting feature. You may page backward and forward through stored alarms in order to identify possible malfunction patterns. ***View Infusion History*** – This can be a troubleshooting feature. You may page backward and forward through stored record of infusion types in order to identify how the pump has been used. ***View Software CRCs*** – For "factory use" only. Allows view of CRCs for each code bank. ***View Software Versions*** – This is where you identify both *bootbank* version and *main* version of software installed in within the pump.
Configuration Cloning	Two pumps can communicate through their built-in infrared serial communications interface, with one teaching and the other learning, to copy pump configuration settings, and libraries.
CPI (Capacity Inaccurate)	This is the *number of shallow discharge cycles* since he last calibration. Always recalibrate the battery when CPI is *> 128*. Refer to the battery calibration.
Depleted Battery Monitor	The circuitry which measures present battery charge status against stored battery capacity data to determine a "depletion" situation.
EN 475 Alarms	The *EN 475* alarms use tones designed for use by customers following European standards. These generate *High, Medium & Low* Priority Alarms
External Power Detector	Circuitry which determines when and if external power (whether AC or DC) has been or is connected to the pump.
Flash Memory	The pump uses flash memory, which is re-programmable through the infrared (IR) port and a remote computer.

High Priority Alarms	A *high priority alarm* results from either any condition which halts an ongoing infusion, or any pump system fault which affects infusion. If the front panel controls are locked when a *high priority* alarm occurs, the pump controls unlock. High Priority alarms are signaled by a flashing red indicator and an audible signal. Press the **Alarm Silence** button to pause the audible alarm for the preset alarm silence period.
Infrared Serial Data Port	The *infrared serial port* interfaces directly with the main microprocessor's asynchronous serial communication pins. The infrared port supports short transmission distances of *2" or less* and a maximum baud rate of 9600.
Infusion Class 4	An infusion pump which combines the functions of continuous infusion flow, intermittent flow, and discrete bolus delivery.
Infusion Class 5	An infusion pump which functions as a profile pump, providing a programmed sequence of delivery rates.
Interconnect Board	The *interconnect printed circuit board* interfaces to an intelligent NiCad Battery, the system speaker, the internal DC supply and supply conditioning for an external DC supply and the main PCB.
IPX3	Equipment which is ingress protected from fluid spraying at vertical angle from above, and from angles to 60° on either side of vertical.
Keypad Test	Verifies individual function of each key on the keypad. Nonfunctioning keys indicate need for keypad replacement.
LCD	Liquid Crystal Display
LCD Back Light	The LED fiber optic light source which illuminates the LCD display.
Limit Priority Alarms	A *limit priority alarm* is generated whenever a preset *minimum* or *maximum* limit has been violated. For example: when programming an infusion there are minimum and maximum limits preset rates assigned to syringes by size & manufacturer. • The LIMIT priority alarms sound a 3-second tone with an advisory message onscreen.
LMD (Last Measured Discharge)	This the *learned capacity* of the battery by the gauge following a calibration cycle. Replace the battery when this is *< 1400 mA-hours*.
Low-Priority Alarms	A *low priority* alarm indicates any condition not requiring immediate operator intervention. Low Priority alarms are announced with a continuous yellow indicator and an intermittent audible signal. • Pressing the ALARM SILENCE button permanently silences this alarm. • If the front panel controls are locked when a low priority alarm occurs, the pump controls **do not** unlock.
Medium Priority Alarms	A *medium priority* alarm indicates any condition requiring operator intervention but does not halt infusion. Medium Priority alarms are signaled with a flashing yellow indicator and an audible signal. Pressing the ALARM SILENCE button will silence the audible alarm for the programmed alarm silence period. • If the front panel controls are locked when a *medium priority* alarm occurs, the pump controls **do not** unlock.
Motor Rotation Sensor	A optical sensor on the main board senses the movement of the motor worm shaft.
"Neglected Pump" or User Call Back	The "*Neglected Pump*" or user call back alarm is a low priority alert which simply reminds you to finish what you started. Once you begin programming any infusion, the pump expects you to continue until programming is complete. If you leave the pump paused too long (30 seconds) on any data entry screen, then the pump begins sounding a low priority alert.
Occlusion	The blockage of the infusion line during delivery. Here, the pump detects an occlusion by sensing excessive force on the syringe plunger driver.

Plunger Printed Circuit Board	The plunger PCB provides pre-amplification of the force sensor output to the Main board, and contains two photo-interrupters with supporting circuitry for sensing each plunger flipper.
Safety Class II, Type CF Equipment	See "AC Line Leakage Test" above.
Serial EEPROM	A non-volatile storage device (electrically-erasable programmable read-only memory) which is used on the main board to store calibration, configuration, and infusion history.
Set / View Last PM Date	This allows viewing the last recorded *preventive maintenance* date. This is where you also set the date when completing annual preventive maintenance.
Stepper Motor	A sequentially stepping motor used to drive the plunger head of the pump.
System Failure	A high priority alarm indicating that the pump self-tests have detected a failure in pump operation.
Primary Speaker	The main speaker located in the bottom housing of the pump. All normal alarm/alert tones are generated through this speaker.
Update Firmware	The *firmware* is the software installed in 3000 Series pumps, and which is used to operate the pumps. The firmware may only be updated with a software kit provided by Medex. The Biomed *Update Firmware* option is the utility provided for reinstalling software used to operate 3000 Series pumps. This can be used to upgrade to a newer version of system software. **Note:** Instructions for updating 3000 Series pump operational software are not included in this technical service manual. Instead, they are part of individual software upgrade kit.
View Alarm History	This is a troubleshooting feature. In Biomed Utilities, you may page backward and forward through the stored alarms in order to identify possible malfunctions.
View Infusion History	This is a troubleshooting feature. In Biomed Utilities, you may page backward and forward through the stored record of infusions in order to identify how the pump has been used. The history will contain roughly 50 events.
View Software CRCs	For "factory use" only.
View Software Versions	This is where you identify both the *bootbank* version and the *main* version of the operational software installed in the 3000 Series pump.
Watchdog Circuit	While in the power on state, the auxiliary controller prevents the watchdog Alarm State from occurring by maintaining the AC signal, WATCHDOG_STRB. • The main microprocessor periodically issues the AC signal, PET_WATCHDOG. In the event the

Appendix 2. Retest Guidelines

The following are minimum guidelines for re-calibration and re-testing after repair.

Retest Guidelines Table

Repair Type	From Biomed Calibration Perform:	From Periodic Maintenance Perform:
Pump Opened	None	Quick Check-out
Repair drive-train		
Replace motor	None	Complete Mandatory Annual Maintenance Testing
Replace clutches, square rod, leadscrew, or plunger cable	Recalibrate position & size.	Complete Mandatory Annual Maintenance Testing
Repair sensors		
Replace ear clip or ear clip sensor	Recalibrate size.	Quick Check-out & Calibration Verification
Replace barrel clamp assy or size pot.	Recalibrate size.	Quick Check-out & Calibration Verification
Replace force sensor	Recalibrate force.	Quick Check-out & Calibration Verification
Replace position pot	Recalibrate position & size.	Quick Check-out & Calibration Verification & Plunger Travel Test
Repair electronics		
Replace speaker	None	Quick Check-out
Replace Interconnect cable	None	Quick Check-out
Replace AC supply	None	Quick Check-out
Replace battery	None	Quick Check-out & after AC charging run Power-up Tests
Replace interconnect board	None	Quick Check-out
Replace keypad, display or backlight	None	Quick Check-out & Calibration Verification
Replace main board/component	Recalibrate all sensors.	Complete Mandatory Annual Maintenance Testing
Replace plunger board/component	Recalibrate force.	Quick Check-out & Calibration Verification
Software Updates		
Reprogramming	See update instructions	See update instructions
Repair case or case parts		

Replace case bottom	None	Quick Check-out
Replace case top	Recalibrate all sensors.	Complete Mandatory Annual Maintenance Testing
Replace case handle	Recalibrate position & size.	Quick Check-out & Calibration Verification
Replace plunger head, or flippers.	Recalibrate force.	Quick Check-out & Calibration Verification
Replace IR lens	None	Quick Check-out
Replace plunger lever	None	Quick Check-out
Replace pump labels	None	Quick Check-out
Replace feet	None	Quick Check-out
Replace tubing holders	Recalibrate size.	Quick Check-out & Calibration Verification

Notes

Appendix 3. Index

A

AC Input Assembly 64
Replacing *64*
AC Line Leakage Test 10
AC Power 3
AC Power Detection Description 33
AC Power Input & Power Supply Circuit Board 17
AC Power Supply 63
Replacement *63*
Verify Function *63*
Accessories 148
Adjust Contrast Voltage Setting 90
Alarm Message 38
Alarm Priorities & Messages 38
Alarm Priority – Programming 38
Alarm Priority –Infusing 38
Alarms / Alerts 37
Always On Supply 25
Analog Supply 27
Analog to Digital Converter 22
Appendicies 151
Assembly Drawings 131
Assembly, Barrel Clamp 142
Assembly, Case Bottom 134
Assembly, Case Top with Plunger 136
Assembly, Case Top without Plunger 139
Assembly, Clutch 146
Assembly, Drive Train 144
Assembly, Main Pump 132

B

Back Light Supply 27
Backup Audio Buzzer 25
Backup Super Capacitor 25
Battery Board 36
Battery Calibration Procedure 11
Battery Charger 35
Battery Gauge Function 36
Battery Gauge Interface 34
Battery Maintenance 11
NiCad 11
Battery Management 34
Battery Pack 60
Replacing *60*
Verify Battery Pack Function *60*
Battery Shallow Discharge Record **11**
Battery Switchover 35
Biomed Calibration 84
Biomed Calibration Kit 84
Biomed Diagnostics 48
Biomed Major Options 2
Biomed Mode, Understanding 2
Bottom Housing 65
Replacement *65*

C

Calendar Clock 16
Calibrate Force Sensor 87
Calibrate Plunger Position Sensor 89
Calibrate Pressure Sensor 88
Calibrate Syringe Size and Position 85
Calibrate Syringe Size Sensor 90
Calibration & Adjustment 84
Charge Detector 35
Cleaning and Care 4
Cleaning Cautions 5
Closing the Pump 59
Controlling Motor Functions 14

D

Data Input / Output to LCD 28
DC Power Converter 16
DC Power Input Jack 17
DC to DC Converter 26
Depleted Battery Monitor 36
Digital to Analog Converter 22

E

ESD handling precautions 12
European Service 47
Exit Calibration without Saving Changes 91
Expansion Port # 1 23
Expansion Port # 2 24
External DC Power Conditioning / Detection 33

F

Flash Memory 21
Force Preamplifier Function 32
Force Sensing Interface Description 32
Front Panel Interface Description 27

G

Graphic Display Interface Description 28
Graphical Display Unit (LCD) 16

H

High-priority 37

I

I/O Port Expansion 23
Infrared Receiver 34
Infrared Serial Data Port 34
Infrared Transceiver 22
Infrared Transmitter 34
Infusion Class 4 ..... **13**
Infusion Class 5 ..... **13**
Infusion Control & Safety Functions 14
Interconnect Board 33, 61
Replacing *61*
Interconnect Printed Circuit Board 17
IPX3 13

K

Keypad 16, 73
Replace73
Keypad Matrix Interface 27

L

LCD 16

LCD and Backlight 72
Replacement *72*
LCD Back Light 28
LCD Contrast 28
LED Drive Circuit 27
Logic Core of *3000 Series Pumps* 15
Logic Kernel Description 19
Logic Supply 26
Low-priority 37

M

Main Board 19, 66
Removing *66*
Replacement *66*
Main Circuit Board 15
Main Microprocessor Interface 19
Main Processor 15
Maintenance Tools 3
Maintenance Warnings/Cautions 57
Maintenance, Periodic 4
Medex Service Assistance 47
Medium-priority 37
Motor Current Detector 29
Motor Current Regulators 29
Motor Drive Description 29
Motor Drive Test 8
Motor Rotation Sensor 16
Motor Speed Detection 29
Motor Supply 26

N

Negative Supply 27
Never Autoclave 5
NiCad Battery Pack 17
nominal voltage 36

O

Opening & Closing the Pump Casing 59
Opening the Pump 59
Overview of Operation 14

P

Parts Lists 131
Parts Replacement 57
Plunger Board 32
Plunger Flipper Sensor Function 32
Plunger Force Sensor 17
Plunger Loaded Sensor 17
Plunger Position Sensing Description 30
Plunger Position Sensor Test 7, 8
Plunger Printed Circuit Board 17
Plunger Travel Sensor 16
Power Control Description 25
Power Control, Always On Supply 25
Power Control, Backup Audio Buzzer 25
Power Control, Backup Super Capacitor 25
Power Control, System Reset 25
Power OFF State *26*
Power ON State 26
Power On/Off Management 26
Power Switch Interface 27
Problem Solving Procedures 37
Programming Flash Memory 21
Pump Design Description 15
PWM Current References 29

R

Real Time Clock 16
Rechargeable Battery Pack & Battery Gauge 17
Removing AC Input Module Assembly 64
Removing AC Power Supply 63
Removing LCD and/or Backlight Assembly 72
Removing the Bottom Housing 65
Removing the Keypad 73
Removing the Main Board 66
Replacing AC Input Module Assembly 64
Replacing the AC Power Supply 63
Replacing the Bottom Housing 65
Replacing the Keypad 73
Replacing the LCD and/or Back Light Assembly 72
Replacing the Main Board 66
Requirements for Battery Replacement 12
Returning Pump for Repair 47

S

Safety Class II, Type CF equipment 10, 154
Schematics & Assembly Drawings 93
Serial EEPROM 21
Service & Support 47
Severely Depleted Battery Monitor 36
Shallow Discharge Record 11
Speaker 17, 62
Replacement *62*
Speaker Control 31
Speaker Drive Description 31
Speaker Test 31
SPEAKER_DETECT 31
Spray Resistant 5
Standard Cleaning 5
Static Random Access Memory 21
Stepper Motor 16
Syringe Ear Sensing 30
Syringe Flange Loaded Sensor 16
Syringe Flange Sensor 16
Syringe Sensing Description *29*
Syringe Size Sensing 30
Syringe Size Sensor 17

T

Techincal Definitions, Labeling 13
Theory of Operation 13
Time of Day 21
Troubleshooting 37

U

Unauthorized Biomed Access 1, 2
United States Service 47

V

Verify AC Power Supply Function 63
Verify Battery Function After Replacement 60
Verify Interconnect Board Function 61
Verify LCD & Backlight Assembly Function 73
Verifying AC Input Assembly Module Function 64
View Calibration Data 91

W

Watchdog 26
Watchdog Circuit 16

Notes